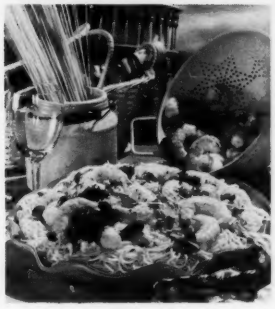
Marine Fisheries REVIEW

February 1983
Vol. 45, No. 2

National Oceanic and Atmospheric Administration • National Marine Fisheries Service

Attitudes Toward Seafood

Marine Fisheries REVIEW



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National Marine Fisheries Service

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Marine Fisheries Review (USPS 090-080) is published monthly by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., Bin C15700 Seattle, WA 98115.
Single Copies and annual subscriptions are sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Prices are: Single copy, $3.25 domestic, $4.10 foreign; annual subscription, $18.00 domestic, $22.50 foreign. Copies of individual articles, in limited numbers, are available from the Publications Services Branch (E/AI13), National Environmental Satellite, Data, and Information Service, NOAA, 11400 Rockville Pike, Rockville, MD 20852. News items are not reprinted.

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Botulism and Heat-Processed Seafoods

JOSEPH J. LICCIARDELLO

Introduction

From 1899 to 1973 there have been 688 reported outbreaks of botulism in the United States, involving 1,784 cases and 978 deaths (Center for Disease Control, 1974a). Seventy-two percent of the outbreaks were associated with home-canned foods, whereas commercially processed products were involved in only 9 percent of the outbreaks. In Japan, Canada, Sweden, Denmark, and Russia, the majority of outbreaks have been due to improper home preservation of fish and fish products. Since 1940 there has been a decline in the number of botulism cases in the United States. This is believed attributable to an improvement in canning procedures both in the home and industry.

When one considers the total number of cans of commercially processed food produced in this country since the inception of the canning industry, on the whole the overall safety record pertaining to botulism is remarkable. Out of 775 billion cans of food sold between 1926 and 1971, only three cans have produced (four) fatal cases of botulism (Borgeson, 1971).

Most botulism cases associated with commercially processed foods have not involved fully sterilized products, but semi-preserved products (i.e., smoked, brined, pickled, pasteurized) which must be refrigerated and which rely upon salt content, pH, etc., for semi-preservation. In such products, the commensal microbial flora has been either reduced or inhibited, whereas the spores of *C. botulinum* may be unaffected. Under suitable conditions, germination and outgrowth may occur without competition from other bacterial types, producing toxins—and sometimes with no outward sign of spoilage.

Nevertheless, when botulism from commercially produced foods does occur, the sensational publicity generated by the insidious nature of the disease arouses great concern and accusations which diminish public confidence in the food industry involved. This causes serious economic loss to the affected industry. Rebuilding public confidence in such situations may take 2 years or more (Anonymous, 1978).

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Commercial Seafood Products Involved

The principal habitat of *C. botulinum* is in soil; therefore, it is not surprising that vegetables have been implicated in the majority (17.4 percent) of U.S. outbreaks (Center for Disease Control, 1974a). Fish and fish products have been implicated in 4.4 percent of all outbreaks, whereas meat products were involved in 1.7 percent. However, in 66.7 percent of all outbreaks, the vehicle for the intoxication was either not known or not reported (Center for Disease Control, 1974a).

Botulism associated with commercially prepared fish products in the United States has involved canned clams, clam juice, crab, salmon, sardines, sprat, tuna, and smoked or vacuum-packed ciscoes and whitefish (Meyer and Eddie, 1965; Center for Disease Control, 1974a). Most of these products, however, are usually consumed directly from the container at ambient temperature with no further culinary preparation which could inactivate any toxins.

Distribution and Occurrence in Fish

There are seven known strains or types of *C. botulinum*, designated type A to G, which produce pharmacologically identical but serologically distinct toxins. Types A, B, E, and F are responsible for human botulism, whereas types C and D are usually associated with birds and animals (Smith and Holdeman, 1968). The role of type G has not yet been established.

The predominant strain in fish-related botulism has been type E, although types A and B have been occasionally implicated. Type E *C. botulinum* is ubiquitously distributed in nature and has been isolated from terrestrial soils, rivers and freshwater lakes, marine muds and waters, warm waters (i.e., Gulf of Mexico), and cold waters (i.e., Baltic Sea) (Graikoski, 1971; Hobbs, 1976). It has been found in such principal U.S. fishing areas as the Great Lakes, Gulf of Mexico, and the Atlantic and Pacific coasts (Dolman, 1957; Bott et al., 1966; Ward and Carroll, 1965; Nickerson et al., 1967; Presnell et al., 1967; Ward et al., 1967; Craig et al., 1968; Eklund and Poysky, 1970; Laycock and Longard, 1972).

Type E *C. botulinum* seems to have its greatest concentrations in bays,

estuarine areas, and the surrounding land masses. These areas act as catch basins for rivers draining the contiguous land masses and thus maintain reservoirs of the organisms in the immediate environs (Graikoski, 1971). However, type E habitat is not confined to littoral waters. Dolman (1957) isolated the organism from benthic mud off the coast of British Columbia at depths ranging from 153 to >765 yards (140 to >700 m). Laycock and Longard (1972) detected it in waters 150 miles (241 km) off the northeast coast of Newfoundland, and the spores are probably disseminated throughout the marine environment by underwater currents.

Since the organism inhabits marine and freshwater environments, it has been detected in or on the associated fauna. In infected fish or shellfish, it is usually found on the slime or exoskeleton, the gills, and in the intestinal tract (Huss, 1981). Among salmon taken in Alaskan waters (coastal and rivers), the number of positive gill samples exceeded the number of positive viscera specimens, particularly with the fish caught in rivers (Houghtby and Kaysner, 1969). The authors believed the gills were acting as filtering agents.

While much research has been directed toward establishing the qualitative incidence of type E *C. botulinum* in various fishes, there remains a paucity of information on the concentration of viable cells or spores, particularly in edible portions. A survey by Goldblith and Nickerson (1965) for the quantitative contamination by type E *C. botulinum* of commercially produced haddock fillets in Boston, Mass., revealed that about 24 percent of the samples taken from five different processing plants were contaminated, but the highest level found in any of the samples was 17 organisms per 100 g of fillets. No attempt was made to differentiate between cell and spore content. The incidence of type E spores among herring taken from Norwegian fishing grounds was estimated at ≤1 spore per 16 g of fish (Cann et al., 1966). The highest level of type E organisms found in Gulf of Maine groundfish intestines was 10 per 100 g (Nickerson et al., 1967). These limited data suggest a low natural level of type E botulism spores on finfish; however, the fact that a significant part of the raw material is infected provides the potential for introduction and buildup of the organism in a processing plant unless strict safeguards and good manufacturing practice (GMP) are maintained.

Recent Cases With Commercially Packed Fish

Botulism concerns were greatly stimulated in 1963 when commercially prepared foods were responsible for more cases of the disease in the United States than foods processed in the home (Dowell et al., 1970). Three cases and two deaths in Detroit, Mich., resulted from commercially canned tuna containing type E toxin. Seventeen cases and five deaths due to type E botulism in some southeastern states were associated with vacuum-packed smoked whitefish chubs which had been inadvertently held at room temperature (Dack, 1964; Center for Disease Control, 1974a).

In 1974 a recall of canned tuna was issued by the Food and Drug Administration (FDA) after botulinum toxin type C was detected in one can (Center for Disease Control, 1974b). Packed in Samoa, the can was reportedly an "obvious leaker." In Great Britain during 1978 four cases of botulism with two deaths were attributed to a single can of salmon packed in Alaska (Corwin, 1980), but damaged sometime after processing. This was the first such case in the long history of canning which resulted from commercially canned salmon produced in a U.S. plant. FDA attempts to reproduce the specific can damage in the canning plant were unsuccessful.

More recently, in early 1982, another incident with one associated death involving canned salmon from Alaska was reported in Belgium (Anonymous, 1982a; 1982b). A tiny hole was found in the sidewall of the can near the bottom seam. Unlike the earlier cases, it was speculated that the defect may have been caused in the plant by the can reforming equipment which may have caused tears in the edges of the can. For economy in shipping, some canneries receive formed but collapsed can bodies and use a reforming machine to restore these flattened bodies to a cylindrical shape, after which the body is flanged at both ends and a cover attached to one end.

Determination of a Safe Commercial Process

To appreciate the inherent protection from botulism in commercially canned foods, a brief discussion follows of the principles involved in determining process times. Thermal process requirements for commercially canned low-acid foods were originally based on a mathematical integration of heat penetration data and thermal resistance of the most heat-tolerant pathogen, *C. botulinum*. The heat resistance data were derived from a thermal death time (TDT) curve established by Esty and Meyer (1922) for an initial inoculum of 60 billion spores of the most heat-resistant strains of types A and B *C. botulinum* in M/15 phosphate buffer pH 7. An extrapolation of that curve indicated a TDT of 2.78 minutes at 250°F (121°C).

Townsend et al. (1938) applied a correction to the data of Esty and Meyer for heating lag time and recalculated the TDT at 250°F to be 2.45 minutes. The number of minutes required at any given temperature to inactivate the above spore load of *C. botulinum* is designated the *F* value for that particular temperature. Thus, by this definition $F_{250} = 2.45$, and this value may be used as the reference for safety when calculating the sterilizing value of a canning process. Other time-temperature combinations, i.e., 24.5 minutes at 232°F (111.1°C), 245 minutes at 214°F (101.1°C), etc. obtained from the TDT curve would also provide a sterilizing value equivalent to 2.45 minutes at 250°F. For the sake of conformity, 250°F has been designated the reference temperature in thermal process calculation and a

process which receives a sterilizing value equivalent to 2.45 minutes at 250°F would satisfy the requirement for a minimum botulinum cook; however, for safety reasons industry commonly considers the "minimum botulinum cook" as equal or equivalent to $F_{250} = 3.0$. This sterilizing value is applied in the absence of satisfactory TDT data which would show that a lower sterilizing value is appropriate.

Another parameter often used in thermal process evaluation is the *D* value, referred to as the death rate constant, or decimal reduction time. This is defined as the time required at a given temperature to effect a 90 percent reduction in numbers of the organism during heating, or the time required for the rate-of-destruction curve to traverse one log cycle when numbers of survivors are plotted as a function of heating time on semilog paper. The D_{250} for *C. botulinum* spores in phosphate buffer was determined to be 0.20 minutes (Schmidt, 1964). If the thermal death time value of 2.45 minutes (at 250°F) is divided by the D_{250} value of 0.20 minutes, a value of 12 is obtained. This indicates that the 60 billion spores in the study of Esty and Meyer were reduced by 12 log cycles or a factor of 10^{-12} after heating for 2.45 minutes at 250°F. Consequently, a sterilizing process designed to effect a minimum botulinum cook is also termed a 12 *D* process.

One perspective for perceiving the safety factor inherent in a minimum botulinum cook is to envision 60 million cans of product each arbitrarily containing 1,000 *C. botulinum* spores. Theoretically, after a minimum botulinum heat process, only one among all these cans would contain a viable spore. Today commercial heat processes for low-acid canned foods are usually not designed principally for the destruction of *C. botulinum,* but rather for the spores of more heat-resistant nonpathogens such as Putrefactive Anaerobe 3679, a strain of *Clostridium sporogenes* which could cause putrefactive spoilage if they survived the process (Lewis and Hall, 1970).

Stumbo et al. (1975) recommended a sterilizing value (F_{250}) of 5-6 for commercial heat processes for low-acid conduction-heating canned foods at a retort temperature of 240°F to obtain sterility with a moderate degree of assurance that only minor economic losses from spoilage by spore-forming mesophilic bacteria more heat resistant than *C. botulinum* would result. However, when good thermal resistance data are available, thermal processes may be based on sterilizing values that are somewhat lower than 5 or 6. Commercial processes today are generally based on these recommended *F* values of 5-6. This is twice the lethal requirement of *C. botulinum* and thus provides a wide margin of safety.

One must caution, however, that these sterilizing values are founded on moist-heat inactivation kinetics where bacterial spores are relatively heat-labile. Bacterial spores are more resistant with dry heat, i.e., in a hot-air oven or in oil. Lang and Dean (1934) found *C. botulinum* spores to be more resistant in fish products packed in oil. Neufeld (1971) recovered viable microorganisms from some cans of organoleptically sound, commercially heat-processed fish products, with survival attributed to fat protection since the isolated cultures were not found to be heat resistant.

Canned foods are not generally considered absolutely sterile but rather "commercially" sterile. This term implies that a few viable or injured cells may be present in a product, but growth and multiplication are suppressed by environmental conditions in the substrate. In low-acid canned foods, spores of heat-resistant thermophiles such as *B. stearothermophilus* are the only ones which are expected to survive the processes used.

Another factor which contributes to the prevention of botulism is the heat lability of the toxin. Simply heating the food to the boiling temperature before eating should be sufficient for detoxifying a product (Licciardello et al., 1967). Most outbreaks with commercially packed seafoods involve products which may be served cold and directly from the can (i.e., tuna, crab, and sardines).

Factors Responsible for a Botulism Hazard

In contrast to type A and type B spores, the spores of type E *C. botulinum* are relatively heat sensitive (Angelotti, 1970), and would be easily destroyed by a conventional commercial heat process as designated by the National Food Processors Association (1966). It has been stated that all outbreaks of botulism from U.S. commercially canned foods in recent years have been due to technical errors and not to the recommended thermal process itself (Lewis and Hall, 1970).

For example, the presence of *C. botulinum* in commercially canned mushrooms was thought to have been caused by use of a new type of filling machine which tended to pack the mushrooms into a solid mass in the container, thus altering the heat penetration characteristics. The processor unwittingly continued to maintain the same process schedule which resulted in an underprocessed product. Processing time should be redetermined whenever there is any change in product formulation involving particle size, drained weight, consistency, etc., which could affect heat transfer characteristics.

The 1963 outbreak in Detroit, Mich., resulted from recontamination of canned tuna due to a faulty seal (Stersky et al., 1980). The mechanism by which this can occur is as follows: As soon as steam pressure is released in a retort at the end of a thermal process, and while the cans are still hot, a tremendous strain is imposed on the container seams and microleakage can occur, particularly if the can had been sealed by a seaming machine that was out of adjustment or had badly worn rolls. During the cooling period a negative pressure develops within the can, and in a can with a defective seal, the cooling medium (air or water) can be sucked in. Although can sizes of approximately 4 inches diameter and smaller are normally designed to withstand internal pressures which

develop if the sterilizer steam pressure is suddenly released, can sizes greater than 4 inches diameter must be cooled under pressure to prevent straining and/or buckling of the container ends. Failure to pressure cool properly can lead to leaker spoilage problems with these large diameter cans. Post-process recontamination can be reduced by treatment of the cooling water with an effective germicide, by gentle handling of filled containers to avoid damage to sealed ends, and by proper sanitation of can runways and equipment (Bee and Hontz, 1980; Ito and Seeger, 1980).

Significance of z Value in Determining Process Times

The strains of *C. botulinum* found in fish or marine foods are usually of the nonproteolytic variety (type E and some types B and F). This is fortunate in the respect that nonproteolytic strain spores are less heat resistant than those of proteolytic strains. However, it is unfortunate because the proteolytic strains produce a putrid, recognizable spoilage pattern which would be a deterrent to the consumption of a toxic product, whereas spoilage and toxin production induced by the nonproteolytic types are usually less evident. In addition, nonproteolytic strains are capable of growing at lower temperatures, e.g., 37.4°-41°F (3°-5°C) (Hobbs, 1976).

Most type E outbreaks with commercially processed fish, particularly during the early 1960's, have been associated with inadequately refrigerated smoked fish. As a result, a code of practice was instituted for commercial production requiring smoked fish (from the Great Lakes) to be heated at least 30 minutes to an internal temperature of either 180°F (82°C) if the salt content of the aqueous phase is 3.5 percent, or 149°F (65°C) if the salt concentration is 5.0 percent (Liston, 1980). However, it has been demonstrated that this process schedule may not be adequate for complete elimination of type E spores from contaminated fish (Christiansen et al., 1968; Pace et al., 1972).

When establishing a process schedule, the objective is usually the destruction of the most heat-resistant strain of a particular bacterial species. Quite often the thermal resistance of different bacteria may be compared either through their thermal death times or *D* values at a particular temperature. This would be a valid comparison only if the slopes of the TDT curves were the same (Townsend et al., 1938). In thermal processing terminology, the slope of a bacterial TDT curve, expressed as the degrees Fahrenheit intercepted by the curve in traversing one log cycle, measures the change in thermal death time as a function of temperature. This parameter is called the z value. Another concept of the z value is that it represents the number of Fahrenheit degrees required to cause a tenfold change in heating time to achieve the same lethal effect. In the classic study by Esty and Meyer (1922) referred to previously, the z value in phosphate buffer was found to be 18. As this value becomes smaller, the effect of a processing temperature change becomes more marked. Thus, two strains of type E spores with different z values could have the same heat resistance at one particular temperature, but the spores with the smaller z value will be more resistant at lower temperatures and less resistant at higher temperatures (Perkins, 1964). A thermal process based on the heat resistance of the spores with the higher z values in this case would result in underprocessing (Perkins et al., 1975).

The z values for various strains of type E spores in either water, phosphate buffer pH 7, or trypticase peptone glucose broth have been reported to range from 7.4 to 17 (Ohye and Scott, 1957; Schmidt, 1964; Roberts and Ingram, 1965; Crisley et al., 1968; Ito et al., 1970; Lynt et al., 1977). Although the substrate is known to affect the z value, variable values were reported even in situations with the same substrate. There are essentially two different methods for determining the z value: 1) From a TDT curve constructed from end-point destruction data, and 2) from a phantom TDT curve obtained by plotting log *D* value as a function of temperature (Perkins, 1964).

Experimental Comparison of z Value for *C. botulinum* Type E by Tv ɔ Different Methods

Because of the reported variability in z value for type E *C. botulinum* spores, the following study was conducted to determine the influence of the particular method by which the value was derived. Thermal destruction rates were determined for two strains of type E *C. botulinum* spores (8E and Detroit) in either M/15 phosphate buffer pH 7.0, clam liquor, or a haddock slurry over a temperature range of 140°-180°F (60.0°-82.2°C). The spore suspensions were heated in a thermostatically controlled mineral oil bath in sealed melting-point-determination capillary tubes which allowed rapid heating or cooling to ambient temperature (Licciardello and Nickerson, 1962). The number of survivors was counted by aseptically crushing the acetone/chromic acid cleaned tubes in sterile diluent and inoculating appropriate dilutions into Miller-Prickett[1] tubes containing 0.5 ml of 5 percent filter-sterilized sodium bicarbonate solution and then adding 10 ml of a molten agar medium (50 g trypticase, 5 g peptone, 10 g glucose, 0.5 g sodium thioglycollate, 0.5 g ferric citrate, 1 g K_2HPO_4, 1 liter distilled water, pH to 7.2). Tube cultures were incubated 48 hours at 85°F (29.4°C) before counting colonies.

A typical set of survivor curves is shown in Figure 1 for strain 8E in a haddock slurry. The nonlinear survival curve with heat-resistant tail exhibited by 8E in haddock slurry also occurred with the other substrates and with the Detroit strain. Lynt et al. (1977) also reported a tailing effect for thermal destruction of type E spores. The *D* value was calculated for each heating temperature from the reciprocal linear regression slope of the survival data over the first three to

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

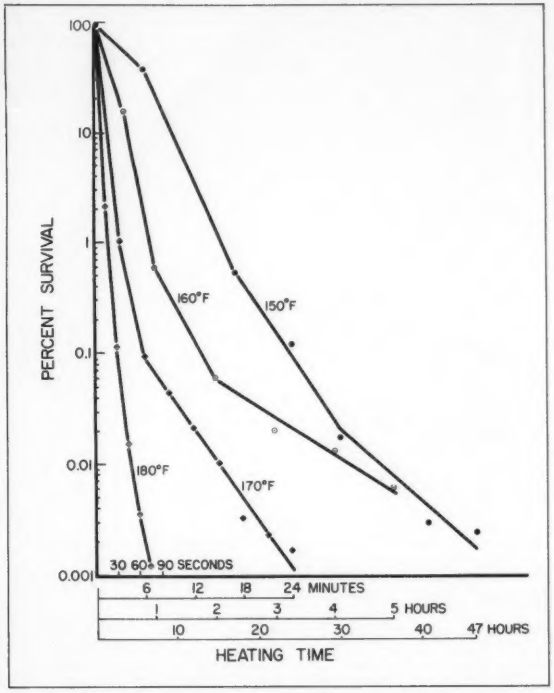

Figure 1.—Survivor curves for spores of *C. botulinum* type E (8E) heated in a haddock slurry. Each point represents the average count of duplicate tubes.

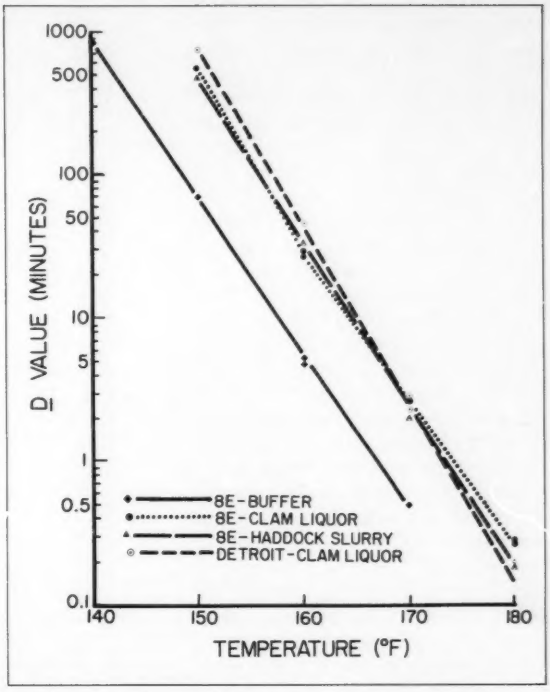

Figure 2.—Phantom TDT curves for spores of *C. botulinum* type E in various substrates. Each point represents result of separate trial.

four log cycles of destruction. Although it is acknowledged that this procedure for determining *D* value is valid only for linear survival curves, in this case the value so derived would be applicable to 99.9-99.99 percent of the population, which for all practical purposes can be considered to represent the population. The *D* values obtained in this study support the general conclusion of others that type E *C. botulinum* spores are relatively heat sensitive.

Phantom TDT curves are shown in Figure 2. The z values calculated from regression slopes were as follows: For strain 8E, 9.2 in phosphate buffer, 9.3 in clam liquor, and 9.0 in haddock slurry; for the Detroit strain, 8.2 in clam liquor.

Thermal death times were determined by the end-point method for the Detroit strain in clam liquor. A series of five capillary tubes, each containing 150×10^6 spores was heated for various time intervals at either 170, 180, 190, or 200°F (76.7, 82.2, 87.8, or 93.3°C) and then aseptically subcultured in TPG broth tubes and stratified with vaspar. Following a 2-week incubation period at 85°F (30°C), each culture tube was examined for viability by phase microscopy and for presence of type E toxin by mouse intraperitoneal injection. A TDT curve was constructed by drawing a straight line between the interval of heating times for the last set of toxin-positive tubes and the first set of five toxin-free tubes for each temperature (Fig. 3). From this TDT curve a z value of 17 was calculated, and this is to be compared with the value of 8.2 obtained from the phantom TDT curve. Lynt et al. (1977) similarly computed a higher z value from the TDT curve compared with the phantom TDT curve for strains of type E *C. botulinum* spores in crab meat. The discrepancy may be due to the fact that the TDT curve was based on the thermal resistance of a very small proportion of heat resistant spores in the population, whereas the phantom TDT curve was derived from the resistance of the major fraction of the population which was relatively heat sensitive. The question has long been debated whether the extreme heat resistance often encountered in a very small proportion of a bacterial population is due to 1) a physical phenomenon (i.e., clumping), 2) the presence of some dried spores on the inside wall of the TDT tube being subjected to dry rather than moist heat, or 3) a variation in physiological condition among the spore population. However, in this study and also in another (Graikoski and Kempe, 1964), it was demonstrated that the extreme heat resis-

tance was not an inherent trait, since spore crops produced from the resistant survivors possessed the same thermal resistance as the parent culture. That type E *C. botulinum* heat-resistant spores do exist is evidenced by the recovery by other investigators of viable type E spores from chubs which had been heated in accordance with the recommended code of practice, i.e., to an internal temperature of 180°F for 30 minutes (Pace et al., 1967; Christiansen et al., 1968). Dolman and Chang (1953) reported that some strains of type E spores withstood 30 minutes exposure to 212°F (100°C). Yet, based on *D* values generally reported for type E strains at 180°F, 30 minutes should exceed a sterility time calculated for a 12 *D* process. In our study the D_{180} for the Detroit strain in clam liquor was 0.2 minutes. A 12 *D* process based on this datum would require 2.4 minutes at 180°F. Yet, from Figure 3 the TDT at 180°F for 150 million spores is shown to be about 65 minutes. Lynt et al. (1977) similarly found that the computed process time for type E spores in crab meat at 185°F (85°C) based on 12 *D* from a phantom TDT curve was much less than the value obtained from the regular TDT curve.

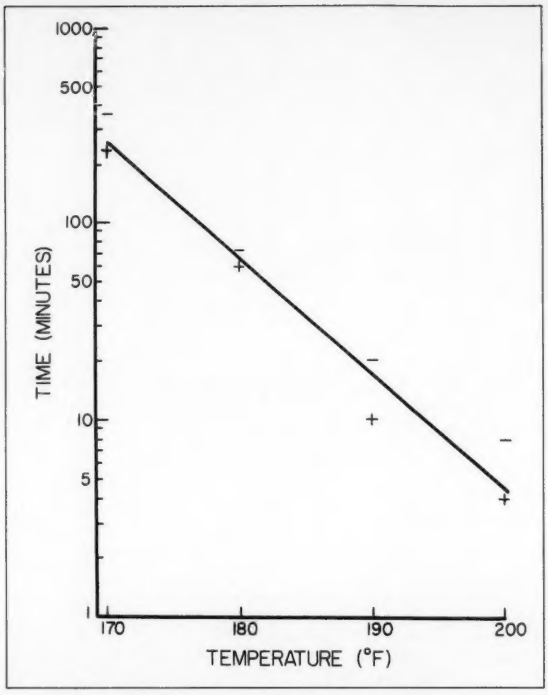

Figure 3.—Thermal death times plot for spores of *C. botulinum* type E (Detroit) in clam liquor (+ = toxin developed in at least one of five tubes after heating and − = toxin did not develop in any of five tubes after heating).

The discrepancy in processing requirement as derived from these two techniques must result from some unaccountable experimental error inherent in one of the two different methodologies. This is also reflected in the differences in z values obtained by the two methods. A possible causative factor could be the differences in incubation time after heating for recovery of viable spores or testing for toxinogenesis. In the TDT method a 2-week incubation period was allowed, whereas in the rate of destruction method the agar tubes could not be incubated beyond 2 days because of extensive gas formation which precluded counting colonies. The gas resulted from the fermentation of glucose which was considered an essential requirement for maximal recovery of type E *C. botulinum*. Also, there is a possibility of differences in recovery, particularly of heat-injured spores, resulting from subculturing in a solid nutrient medium compared with a liquid broth. Finally, enumeration of survivors in the rate of destruction method was based on colony formation, whereas in the end-point method the criterion for survival was toxin production. It is not known whether all surviving spores were capable of toxin production. The important question is which of these two methods is correct. To be realistic, thermal death times would probably be best determined by heating and incubating the spore inoculum in the same substrate for which the process time is being determined. This can be accomplished using TDT cans. It is possible that heat-injured spores may be recovered when subcultured into a nutrient medium whereas these same spores might not be able to germinate and grow out because of an unfavorable environment if left in the heated food substrate. More work is needed to establish the validity of the two methodologies reported here.

Nevertheless, if a food processor bases a process schedule on a minimum botulinum cook, it is not believed that the public health would be compromised. Pflug and Odlaug (1978) have concluded that an F_{250} of 3.0 minutes and a z value of 18 have been the standard for the minimum botulinum cook for more than 40 years and there is no epidemiological evidence to demonstrate that the standard has failed.

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Some Effects of Mt. St. Helens Volcanic Ash on Juvenile Salmon Smolts

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Introduction

The eruption on 18 May 1980 of Mt. St. Helens in southwestern Washington (Fig. 1) resulted in airborne volcanic material being deposited in many watersheds of the Pacific Northwest (Fig. 2). Particularly hard hit was the Toutle River basin on the northwest side of Mt. St. Helens, which was completely decimated with volcanic ash and mud slides.

Heavy sediment loads in the Toutle River were carried downstream through the lower Cowlitz River and into the Columbia River. This sediment load created a plume in the Columbia River which initially extended

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ABSTRACT—Chinook, Oncorhynchus tshawytscha, *and sockeye,* O. nerka, *salmon smolts were exposed to various concentrations of airborne volcanic ash from the 18 May 1980 eruption of Washington's Mt. St. Helens. These bioassays were conducted at Bonneville Dam on the lower Columbia River between 7 and 27 June 1980. In static bioassays, 25 percent (v/v) ash caused 100 percent mortality in 1 hour, whereas 10 percent (v/v) ash caused 60 percent mortality in 6 hours. No mortality was noted at concentrations of 5 percent (v/v) or less airborne ash over 24 hours. In dynamic bioassays with continuous resuspension of ash,* LC_{10} = 0.5 g/l, LC_{50} = 6.1 g/l, *and* LC_{90} = 34.9 g/l *at 36 hours (at 15-17°C; oxygen near saturation).*

The gills of dead juvenile chinook and sockeye salmon smolts were uniformly coated with mucus and volcanic ash; no gross evidence of abrasion or hemorrhage was seen. Impaired oxygen exchange is suggested as the primary cause of death.

Figure 1.—A southeast view of the 18 May 1980 eruption of Mt. St. Helens near Stevenson, Wash. (Photograph courtesy of E. McLarney, Skamania County Pioneer, Stevenson, WA 98648.)

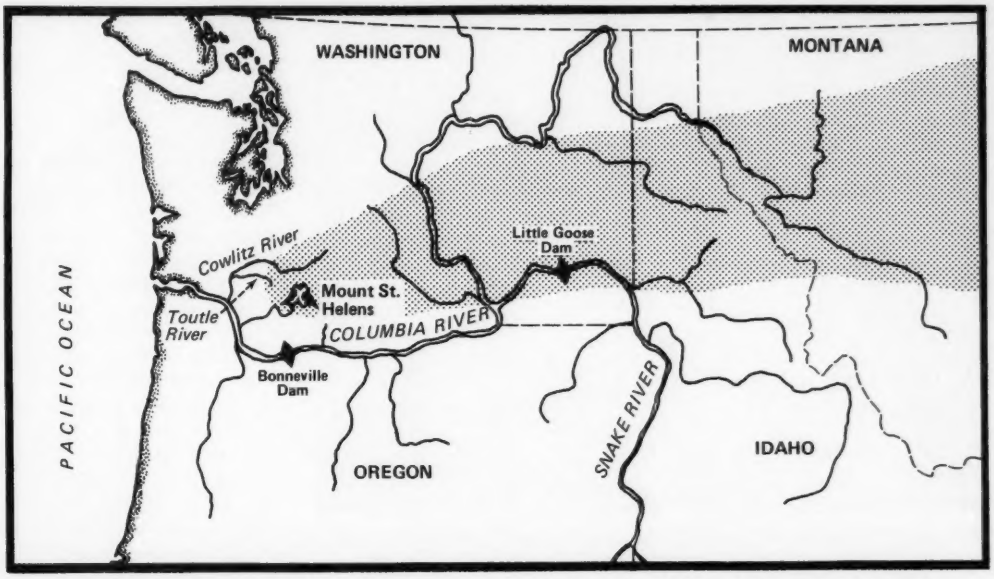

Figure 2.—Fallout pattern of airborne volcanic ash ejected during the 18 May 1980 eruption of Mt. St. Helens. (Redrawn from data supplied by A. Sarna-Wojoicki, U.S. Geological Survey, Western Region, 345 Middlefield Rd., MS-75, Menlo Park, CA 94025.)

68 miles to the estuary. Because the initial major eruptions of Mt. St. Helens occurred during the seaward migration of juvenile Pacific salmon, *Oncorhynchus* spp., and steelhead trout, *Salmo gairdneri,* in the Columbia River drainage, there were major concerns over the effects of the ash on the migrants.

Since 1968, the National Marine Fisheries Service (NMFS) and U.S. Army Corps of Engineers (COE) have been collecting and transporting large numbers of naturally migrating salmon and steelhead trout smolts around the dams of the Snake and Columbia Rivers in an effort to increase survival (Ebel, 1980; Ebel et al., 1973). Currently, the NMFS and COE transport up to 7 million juvenile salmonid smolts annually by truck and barge from the lower Snake and middle Columbia Rivers to Bonneville Dam. The bioassays described in this report were carried out between 7 and 27 June 1980 to investigate the potential impact on these fish of airborne ash from Mt. St. Helens.

Methods and Materials

Three juvenile salmonid stocks were evaluated. Spring chinook salmon, *O. tshawytscha,* smolts (mean fork length = 129 ± 13 mm) were obtained from the Leavenworth National Fish Hatchery (NFH), Leavenworth, Wash.; fall chinook salmon smolts (mean fork length = 75 ± 6 mm) were obtained from the Little White Salmon NFH, Cook, Wash.; and wild stock sockeye salmon, *O. nerka,* smolts (mean fork length = 105 ± 8 mm) collected at McNary Dam on the Columbia River. These fish were transported to the NMFS laboratory at Bonneville Dam (Fig. 2) on the Columbia River and acclimated to Columbia River water for a minimum of 2 weeks before testing.

Fish were starved for at least 2 days before each bioassay and were not fed during each experiment. At the time of testing, fish were randomly sampled and assigned to the bioassay test containers (19 l plastic buckets with about 15 l of ash-water mixture). The bioassay test containers were held in a water bath supplied with Columbia River water to maintain a steady natural temperature.

These bioassays used volcanic ash which fell at the fish collection facilities at Little Goose Dam on the Snake River (Fig. 2, 3). This unleached ash was collected on clean concrete from the airborne deposits which fell as a result of the 18 May eruption. The particulate size of this ash ranged from <5 to 100 μm with the majority of the particles <15 μm in size[1]. This material was composed largely of angular material[2].

Two bioassay methods were used. One method was a static situation representing the initial insult that would occur in an airborne ashfall

[1]D. Rosema, Boeing Commercial Aircraft Co., Materials Technology, P.O. Box 3707, MS 08-48, Seattle, WA 98124. Pers. commun., 1982.

[2]A. Sarna-Wojoicki, U.S. Geological Survey, Western Region, 345 Middlefield Rd., MS-75, Menlo Park, CA 94025. Pers. commun., 1980.

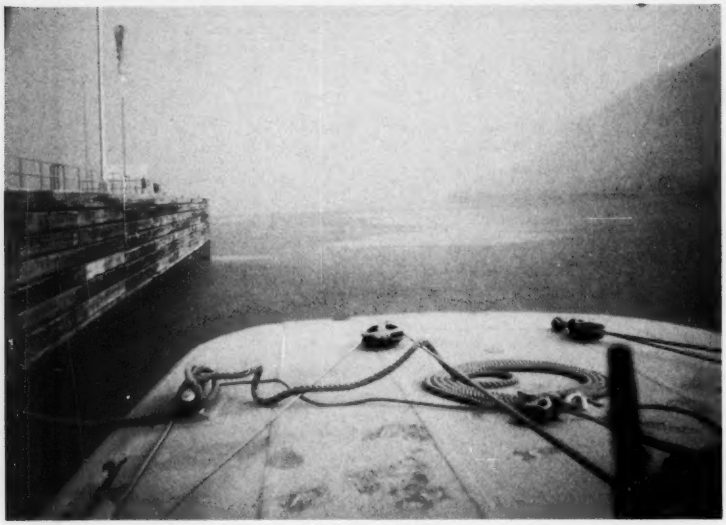

Figure 3.—Volcanic ash falling on the Snake River near Little Goose Dam following the 18 May 1980 eruption of Mt. St. Helens. Note the dark, ash-covered water, the footprints in the ash on the stern of the tugboat, *Patricia*, and the obscuring of the hills in the background. (Photograph courtesy of S. Demuth, NMFS Mukilteo Field Station, P.O. Box 21, Mukilteo, WA 98275.)

over still water. In this bioassay on spring chinook salmon, ash (calculated as volume percent of dry ash/volume of water (v/v)) was introduced at concentrations of 25.0, 10.0, 5.0, 1.0, 0.1, and 0.0 percent. Lethal effects of the water-soluble components of the ash were also investigated.

In this test the fish were exposed to the soluble fraction filtered from a mixture of 25.0 percent ash over Whatman No. 541 paper[3] (retaining 98 percent of particles above 20 μm). Ash at the specified concentrations was initially well mixed, and the fish (n = 15) were immediately introduced into the well-aerated mixtures. With this technique, no further mechanical mixing occurred, and oxygen levels were kept near saturation by means of large air stones. Throughout the test period (24 hours) the temperature averaged 14 °C.

The second bioassay method represented rivers carrying suspended volcanic ash loads. These bioassays consisted of three replicates of 10 fish per concentration for spring chinook salmon, three replicates of 20 fish per concentration for fall chinook salmon, and one test of 10 fish per concentration for sockeye salmon. At least five concentrations of ash, together with a control, were used for each bioassay replicate (10.0, 7.5, 5.0, 2.5, 1.0, and 0.0 percent v/v). In the first replicate with spring chinook salmon, additional concentrations of 0.5, 0.1, and 0.01 percent v/v ash were also used. During the test periods (to 36 hours) water temperatures averaged 15 °C for spring chinook salmon, 17 °C for fall chinook salmon, and 17 °C for sockeye salmon.

Submerged pumps and spray bar arrangements were used in conjunction with air stones to continuously resuspend the volcanic ash load within the test containers. These pumps were not 100 percent efficient in the resuspension of the ash. Therefore, water samples were taken after the introduction of the test fish for determination of the actual suspended ash loads. These samples were filtered (on Whatman GF/B filter paper which retains 98 percent of 1.0 μm particles) and dried to constant weight at 100 °C for 24 hours. Samples were then weighed to the nearest 0.025 g, and the actual concentration of ash held in suspension was calculated as g/l. It was found that, on the average, 20 percent of the introduced material (representing the coarser particles) would not remain in suspension.

In both bioassay procedures the mortalities were monitored at 0.12, 0.25, 0.50, 0.75, 1, 2, 3, 4, 5, 6, 9, 12, 18, 24, 30, and 36 hours. All dead fish were grossly examined to determine cause of death. Gills of selected specimens were microscopically examined to determine the effect of ash particles on the gill epithelium.

Mortality information was compiled and analyzed using the methodology of Doudoroff et al. (1951) as modified by Sprague (1969). Log-log plots of the mortality data were constructed for concentrations lethal to 10 percent of the population (LC_{10}), 50 percent of the population (LC_{50}), and 90 percent of the population (LC_{90}). A least-squares regression equation and a correlation coefficient, r, were then calculated for each log-log plot.

Results and Discussion

Airborne ash has the potential to cause a one-time insult to lakes or other still water. In a static bioassay with juvenile spring chinook salmon, an initial insult (with no further mixing) of 25 percent by volume caused 100 percent mortality in 1 hour, and an initial insult of 10 percent by volume caused 60 percent mortality in 6 hours. Volcanic ash insults of 5 percent and below by volume were not harmful to juvenile spring chinook salmon within 24 hours. Since 5 percent by volume is equivalent to 6 inches of ash falling over a 10-foot

[3]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

water column, most airborne volcanic ashfalls should not cause acute mortality to salmonid stocks in still water. However, hatchery managers should carefully weigh the risk of resuspending airborne volcanic ash when cleaning ponds and raceways.

Airborne volcanic ash material can be held in suspension through the mixing action of river currents. In this study, each test replicate was exposed to a unique suspended ash concentration. Spring chinook salmon were held in concentrations ranging from 0.5 to 87.3 g/l; fall chinook salmon were held in loads ranging from 5.7 to 82.0 g/l; and sockeye salmon were held in loads ranging from 6.1 to 87.8 g/l (Table 1). These concentrations are believed to cover the potential range which may occur in river systems directly draining the affected volcanic area. The 10, 50, and 90 percent linear-regression mortality models (on a log-log basis) are presented in Figures 4, 5, and 6. In all cases, increasing the concentration of suspended volcanic ash resulted in greater overall mortality occurring in progressively shorter time intervals. There was no apparent correlation between fork length or species and the mortality rates noted in the present bioassays.

Our mortality models should be of considerable use to fishery managers involved in assessing the current potential dangers during periods when suspended volcanic ash loads are present in the river systems. The test results indicated that it is the river systems carrying high suspended volcanic ash loads ≥6.1 g/l (Fig. 5) that are hazardous to juvenile salmonids, whereas suspended ash loads >34.9 g/l (Fig. 6) are catastrophic and those <0.5 g/l (Fig. 4) do not present acute (within 36 hours) problems. Fishery managers should keep in mind these mortality rates may be accelerated if the average particle size is larger (Rogers, 1969), or if reduced oxygen levels are present (Peddicord et al., 1975). These mortality rates may be reduced if there is a recent history of exposure to suspended sediment (Noggle, 1978).

In addition, due to design limitations in the present experiments, we were unable to evaluate any additive effect of water velocity as might occur in a river situation.

High levels of suspended sediments may cause mechanical gill damage (Herbert and Merkens, 1961; Noggle, 1978) and/or blockage of the osmoregulatory surface (Ball, 1914; Kemp, 1949). In this study, mortalities appeared to be due to ash particles and mucus causing blockage of the osmoregulatory surface. The gills of dead fish were uniformly coated with ash particles and mucus, and live fish in the high ash concentrations appeared lethargic. There was no gross evidence of abrasion or hemorrhage of the gill filaments. Gills of fresh mortalities were uniformly dark red after gentle irrigation. This suggests impaired oxygen exchange as the primary cause of death.

Table 1.—Relation between the percentage of Mt. St. Helens volcanic ash initially added to bioassay containers and the chronic suspended ash load actually presented to the test fish over the course of the experiments.

Percent ash introduced (v/v)	Suspended ash recovered and dried from Whatman GF/B paper (g/l)		
	No. of tests	Mean	S.D.
10.0	7	82.4	6.5
7.5	7	62.0	2.3
5.0	7	39.3	4.1
2.5	7	19.9	1.9
1.0	7	6.4	0.4
0.5	1	3.1	—
0.1	1	0.5	—
0.01	1	Trace	—

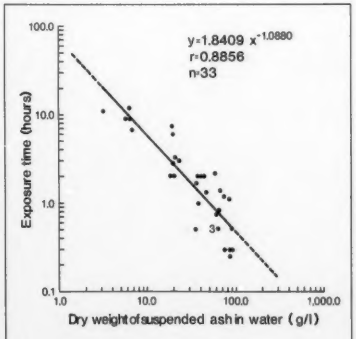

Figure 4.—36-hour LC_{10} for juvenile salmon smolts in mixtures of Columbia River water and airborne volcanic ash collected from Little Goose Dam (at 15-17°C; oxygen near saturation).

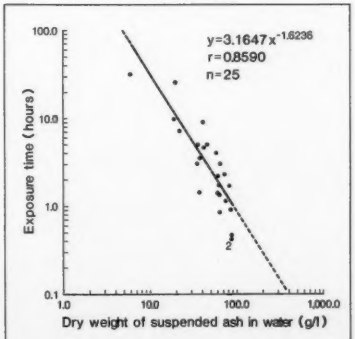

Figure 5.—36-hour LC_{50} for juvenile salmon smolts in mixtures of Columbia River water and airborne volcanic ash collected from Little Goose Dam (at 15-17°C; oxygen near saturation).

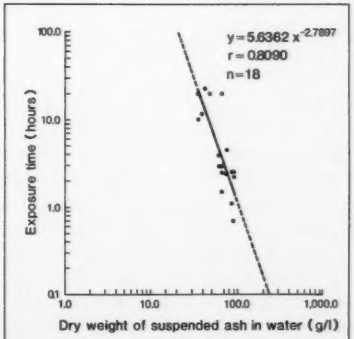

Figure 6.—36-hour LC_{90} for juvenile salmon smolts in mixtures of Columbia River water and airborne volcanic ash collected from Little Goose Dam (at 15-17°C; oxygen near saturation).

There are also possible detrimental effects resulting from the release of water-soluble material (e.g., heavy metals or hydrogen ions) coating the ash. Exposure to the soluble fraction filtered from a mixture of 25 percent (v/v) ash did not result in mortalities even after 36 hours, whereas exposure to an insult of 25 percent (v/v) ash resulted in 100 percent mortality within 1 hour. This further indicated that it is the particulate matter, rather than soluble material coating the ash, that is acutely harmful to salmonids.

The possibility that the release of water-soluble material coating the ash can lower the pH to levels detrimental to salmonids (pH 5.5, McKee and Wolf, 1963) has been of concern to fishery biologists (Kurenkov, 1957). Our measurements indicate that a 10 percent (v/v) level of volcanic ash lowered the pH of the moderately hard Columbia River water used in these bioassays from 7.8 to 7.6. Even though pH was judged not to be a problem in our experiments, it should be noted that each watershed and ashfall has unique chemical properties and should be treated accordingly.

The concentration of ash in the lakes, rivers, and hatcheries east of the blast zone from Mt. St. Helens probably did not exceed the minimum 36-hour LC_{50} level (6.1 g/l, Fig. 5)[4]. In contrast, the initial eruptions of Mt. St. Helens undoubtedly caused the Toutle-Cowlitz and lower Columbia River systems to exceed a concentration of 6.1 g/l. However, our monitoring of these systems indicated that this was not a prolonged situation, except in the Toutle River. The effects of volcanic ash in these systems should be of continuing concern, since either high-runoff situations (causing scouring of the massive deposits of volcanic material in the Toutle River basin) or subsequent eruptions could again inundate these waters.

[4]B. Crawford, Washington Department of Game, Region 5, 5405 N.E. Hazel Dell, Vancouver, WA 98663. Pers. commun., 1980.

Acknowledgments

We wish to thank Teresa Clocksin, Walt Jones, and the CZES Division staff, Northwest and Alaska Fisheries Center, for their inspiration, work, and support under the near-emergency conditions that existed during May and June 1980.

We also wish to thank Tom Casadivall and the U.S. Geological Survey staff at Vancouver, Wash.; Bruce Crawford and the Washington State Game Department staff at Vancouver, Wash.; Dave Rosema and the Boeing Commercial Aircraft Company, Material Technology staff; and Andrei Sarna-Wojoicki and the U.S. Geological Survey staff at Menlo Park, Calif., for their generous help during a very hectic period.

Last, we wish to thank Ed McLarney and the staff of the Skamania County Pioneer, and Sharon Demuth, NMFS, for the generous use of their unique pictures of the 18 May 1980 eruption.

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Seafood Attitudes and Purchase Data Released

The National Marine Fisheries Service (NMFS) has received the first two sets of data from a three-part "Seafood Consumption Survey" conducted by Market Research Corporation of America[1]. The survey was conducted in 1981 using a nationwide panel of 7,500 households. The households completed diaries that provided data on the amount of seafood purchased for home use and on the amount of seafood consumed at home and at restaurants, cafeterias, and other "away-from-home" establishments. The panel households also provided information on attitudes toward seafood. The "purchase" data and "attitudinal" information are now available from NMFS. The "consumption" data, still being processed by Market Research Corporation, were expected to be available in early 1983.

The "purchase" data are presented according to type of seafood products (fresh, frozen, fillets, canned, etc.), by species, region, and a variety of demographics (household size, income, occupation, age, education, race, ethnicity, and religion). The attitudinal information is on type of seafood product, region, and demographics.

The survey is a result of a joint government-industry plan to collect data needed to assess the impact of fishery and other Federal regulations on the seafood industry, to evaluate the nutritional contribution of seafood, and to help with promotional activities.

Data are available in two forms: 1) Statistical tabulations on 8½ × 11-inch paper, with tables printed on both sides, and three-hole punched for inserting into a binder; and 2) magnetic tape. Cost of the hardcopy report (three-hole punched) is 3 cents per page (6 cents per sheet); cost of the tape will be about $50, depending on the data requested. Descriptions of the survey data are listed below by table number.

W.SC. Sample Composition of Weekly Purchase Diary Reporters

This table presents the number and percent of households sampled in the survey compared with the percent of households in the U.S. Census, by nine Bureau of the Census regions, nine NMFS regions, state, metropolitan area size, household size, household income, number of wage earners, occupation of household head, age of household head, education of household head, employment status of homemaker, age of homemaker, presence of children, sex, race, nativity, and religion (5 pages).

W.1.B. Species Bought by Region

This table presents pounds of seafood purchased per household and per capita, and average price per pound for each of 32 seafood categories, 118 species categories, and the nine Bureau of the Census regions (1,280 pages).

W.2.B. Demographic Profiles of Seafood Buyers

This presents pounds of seafood purchased per household and per capita, and average price per pound of each of 74 seafood products categories, nine Bureau of the Census regions, nine NMFS regions, metro area size, household size, household income, number of wage earners, occupation of household head, age of household head, education of household head, employment status of homemaker, age of homemaker, presence of children, sex, race, nativity, and religion (296 pages).

W.4.B. Species Bought by Month

This table presents pounds of seafood purchased per household and per capita, and average price per pound for each of 15 seafood products categories and 31 species categories, by month with quarterly subtotals (465 pages).

A.1.W. Household Demographics of Responses to 80 Attitudinal Questions

This table presents numbers and percentage of respondents and their opinions about each of 40 general statements and 40 statements dealing specifically with seafood. This information is presented for each of the demographics in Table W.2.B. (320 pages).

A.2.W. Attitudinal Profiles of Seafood Buyers

This table presents pounds of seafood purchased per household and per capita, and average price per pound for 32 seafood products categories, and associated with responses to each of 80 attitudinal statements (2,560 pages).

More information on the data available or ordering the data, is available from the Resources Statistics Division, National Marine Fisheries Service (F/SR1), NOAA, Washington, DC 20235.

Experimental Processing Lab Set Up at Charleston

As part of the Fisheries Utilization Program of the NMFS Southeast Fisheries Center's Charleston Laboratory in South Carolina, an expanded experimental processing laboratory (EPL) has been completed. The avail-

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Table 1.—Available equipment[1] at the Charleston Laboratory EPL.

Item	Item
Lapine filleting machine (½-2 pounds)	Dole plate freezer (39 foot² or 180 lb/h freezing capacity at – 40°F)
Simard fish scaler (½-4 pounds)	Hobart blast freezer (55 foot²)
Lapine heading machine (½ to 2½ pounds)	Holding freezers (5) (from – 20°C to – 40°C)
Lapine gutting machine (½-3 pounds)	Stein breading machine
Bibun deboner (no size limit)	
Dixie retort (automatic steam process controls)	Hollymatic patty former
Can seamers (2) (round cans only: 307 × 409, 301 × 411, 211 × 300, 113 × 409); gas flushing/vacuum sealing capabilities	Arenco fillet skinning machine
	Freeze dryer (100 pounds water/48 h)
	Deep fat fryers (2) (batch type)
	Refrigerated seawater and chilled seawater fish storage systems
Vacuum packaging machine (flexible pouches, small to large)	Torry fish smoker (Minikiln: 23 foot²)
Microwave oven (small – 2450 MHz, 1.5 kilowatt output)	Meat saw (sanitary, for blocks or steaks)
Spray dryer (equipped with spray nozzle for liquids)	Small fish (herring-like) scaler
	Mixers, blenders, cookers, scales, etc.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

able equipment allows the use of most forms of preservation such as freezing, chilling, pasteurization, canning, smoking, salting, pickling, and drying. In addition to whole or headed and gutted fish, product forms such as steaks, fillets, deboned mince, patties, and extrusions are possible. The evaluation of alternate processes using equipment made available on loan, lease, or demonstration basis will be welcomed.

It is planned that the EPL will be used both for NMFS and cooperative studies. For cooperative studies the Charleston Laboratory will provide facilities, equipment, operating and process/product expertise, and will collect and assist in evaluating data. Cooperators will provide their raw material, related supplies, and operational personnel, and will also be involved in data collection and analysis. Cooperators can be individual firms, universities, states, Sea Grant Programs, Fisheries Development Foundations or other U.S. entities. The EPL will also be used as a demonstration facility to provide direct experience or hands-on technology transfer to industry of the information generated on the opportunities and limitations of the underutilized fisheries resources and available processes and product forms or concepts.

It is the intent and desire of the National Marine Fisheries Service to make our facilities available (on a cooperative scheduled basis) to the industry and various research groups to prepare pilot-scale quantities of products (and intermediates) for experimental purposes. Since government policies restrict the sale or use for personal gain of products prepared in government facilities, it will be necessary that cooperators supply and retain ownership of materials. The government also reserves the right to use experimental data generated by the cooperative efforts and to supervise the use of the EPL. Quantities of products to be processed and duration of the work can be negotiated.

For more information and to express an interest in using the EPL, please contact Lloyd Regier, Charleston Laboratory, Southeast Fisheries Center, NMFS, NOAA, P.O. Box 12607, Charleston, SC 29412-0607 (telephone 803-762-1200).

The Charleston Laboratory

The NMFS Southeast Fisheries Center's Charleston Laboratory develops and provides technological and scientific information and related services to aid in the economical and safe use of fishery resources of the southeastern United States. The "Fisheries Utilization Program" is focused on the solutions to problems in the handling, processing, nutritional composition, and storage stability of underutilized and traditional species harvested in the region. The "Microconstituents Program" provides an improved detection capability for chemical and biological agents important to human health, and evaluates the significance of these agents, if present in seafood products, and supports research which will assist in resolving identified quality and safety issues. In summary, these programs are designed to provide guidance in the utilization of marine resources while increasing public confidence in seafood products.

The following reports provide summaries of some recent research being conducted at the Charleston Laboratory. Additional information on these topics may be requested by writing or telephoning the noted individual at the Charleston Laboratory, Southeast Fisheries Center, NMFS, NOAA, P.O. Box 12607, Charleston, SC 29412-0607 (telephone 803-762-1200).

1) "Economic Analysis of 'Steam Shock' and 'Pasteurization' Process for Oyster Shucking." This is an evaluation of the variables in the process in terms of cost and potential benefits for methods that can be used to increase shucking rates. (John W. Brown.)

2) "Utilization and Quality Profiles." An annual comprehensive progress report covering recent work on the edibility, composition and frozen storage of several Southeast species. (Malcolm Hale or Beth Elsey.)

3) "Processing Characteristics." The results of laboratory processing studies on several species which were frozen, pasteurized, or canned are included in this brief annual summary report. (Malcolm Hale or Melvin Waters.)

4) "Lipid Oxidation in Mullet and Bluefish Muscle Tissues." A brief report covering the changes that occur in the fats of these fish during refrigerated storage as measured by several different methods for measuring lipid oxidation/rancidity. (Jeanne Joseph.)

5) "Handling Systems—Refriger-

ated and Chilled Seawater Holding." The results of several laboratory trials are presented in this brief report on the comparison of ice, refrigerated sea water, and chilled sea water as systems for holding fish. (Robert Ernst.)

6) "Ciguatera Fish Poisoning." Ciguatera may result from eating semi-tropical reef fishes containing a powerful, naturally occurring poison, ciguatoxin. The report provides background information on the illness and how NMFS and other research groups are dealing with the problem. (Tom Higerd.)

7) "Enteric Viruses in Shellfish." Enteric viruses present a potential human health problem and a threat to the well-being of the industry. The report provides a brief description of the approach by NMFS to develop and promote new methods for detecting and measuring viral contamination. (Gary Richards.)

If information is desired on fisheries utilization topics not dealt with in one of the above recently completed reports, industry members are encouraged to contact the Charleston Laboratory to outline their needs, since a variety of other research is completed or in progress. In addition, the Laboratory has library and computer access to the results of other investigators working on the utilization and development of our marine resources.

Harry L. Seagran, Laboratory Director

Atlantic Bluefin Tuna Quota Increased for 1983

Allen E. Peterson, Jr., Director, Northeast Region of the National Marine Fisheries Service, has announced that during the special meeting of the International Commission for the Conservation of Atlantic Tunas held in Madeira Island, Portugal, in mid-November, the Commission decided to continue conservation measures for bluefin tuna in the western Atlantic. However, the catch limit will be raised from 1,160 t in 1982 to 2,660 t in 1983 to allow for adequate scientific monitoring of the stock. The U.S. share of the catch will increase from 605 t to 1,387.3 t. The shares for Canada and Japan will be 573.3 t and 699.4 t, respectively.

Concern for the continued low level of abundance of small bluefin tuna also resulted in a decision to limit the catch of bluefin smaller than 120 cm in length to be no more than 15 percent by weight of the total catch in the western Atlantic. During 1983, there will be no directed fishery in spawning areas such as the Gulf of Mexico.

Virtual population analyses, which were improved since the 1981 meeting, were used in two different papers which produced some differing results in estimating the population of younger and older fish. The scientists were unable to agree at what catch level a decline in the population will occur. One view was that juvenile levels are 21 percent of the 1960 level, with a further decline likely in adult abundance. The other view was that spawning biomass and potential will increase until 1983 with a decreasing trend thereafter. The scientists believed that the 1982 catches were insufficient to monitor the stock but concluded that the weight of evidence suggests that the catch levels kept should be conservative.

In the eastern Atlantic, the catch of bluefin will continue to be limited to recent mortality levels and the minimum size limit of 64 kg in weight will continue to apply to the entire Atlantic.

The Commission also reviewed the status of all highly migratory species in the Atlantic, such as yellowfin tuna, skipjack tuna, albacore tuna, bigeye tuna, and billfishes. Several areas of concern were noted and the Commission agreed to increase scientific monitoring of these stocks to ensure that timely conservation measures may be implemented should they be called for in the future.

Fish Silage in Aquaculture Diets

Fish silage is a product made from whole fish or fish waste that is liquefied by the action of endogenous fish enzymes in the presence of added acid. Preserving the fish processing waste by ensiling with acids is one possible way to convert the waste material into a usable feed commodity, reports the Northwest and Alaska Fisheries Center's Utilization Research Division.

Economic studies have indicated that the greatest potential large-volume use for fish silage is as a dry product that can be used in animal diets as a replacement of fish meal. Silage can be dried "as-is" or combined with other commodities, such as soybean meal and feather meal, and co-dried.

Feeding trials with rainbow trout using diets containing various dry silage products have shown that fish silage has a place in practical fish diets. Growth of fish fed diets containing silage co-dried with soybean meal and feather meal has been equal to that of fish fed a diet containing fish meal co-dried with soybean and feather meals. Other studies have shown that neutralization of silage made with sulfuric acid with calcium hydroxide is preferable to neutralization with sodium hydroxide or to not neutralizing the silage.

Growth of fish was found to be affected by the degree of liquefaction of the silage. Silage that is partially liquefied and still contains intact protein is preferable to silage that is fully liquefied and contains a larger proportion of free amino acids and small peptide fragments. Further work is planned to determine how to increase the nutritional value of feed ingredients made from fisheries byproducts.

Ronald W. Hardy

The Norwegian Fishing Industry, 1981-82

Considering international and national regulations which were applied to all major fisheries, 1981 was a largely satisfactory year for Norwegian fishermen. Quantitites landed were substantially larger than expected at the beginning of the year and there were no major marketing problems abroad.

Norwegian fisheries yielded 2,680,300 metric tons (t) in 1981, up 6.1 percent over 1980. The ex-vessel value (including subsidies) of the catch was $694.5 million (at US$1.00 = NKR5.50), up 8.8 percent over 1980. Total take of pelagic fish (capelin, mackerel, herring, etc.) was 1,762,300 t, or 3.2 percent more than 1980. Landings of cod and other demersal species were up 11.5 percent to 712,100 t. Other seafood, dominated by seaweed in volume and shrimp in value, increased 14.5 percent to 205,800 t. As in previous years, Norwegian commercial fishing was affected by international and national regulations, such as quotas, bans on fishing in certain areas, and periodic restrictions.

Pacts Limit Fishing

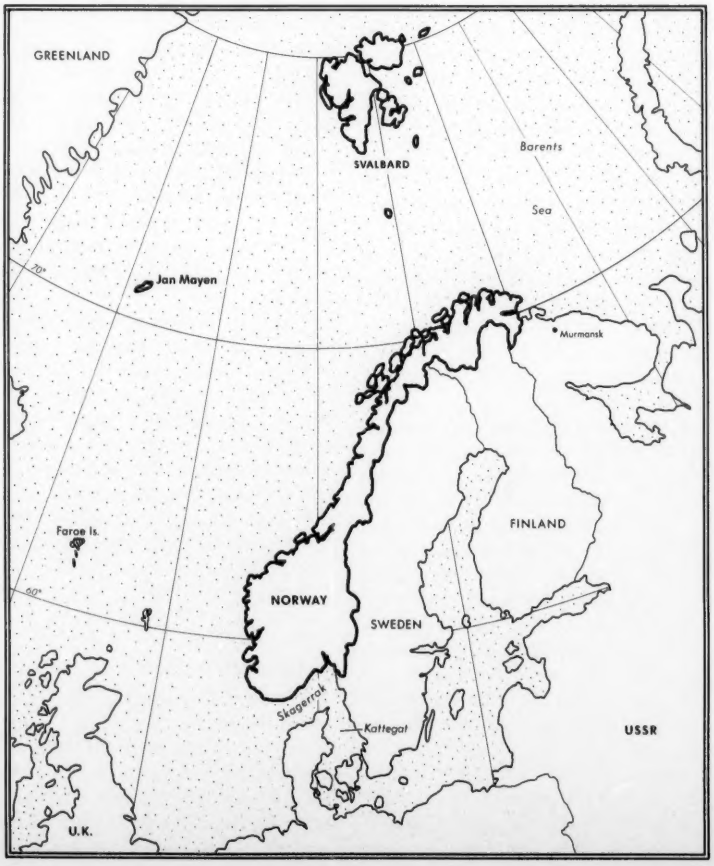
Thus, total allowable catches (TAC) of Arctic cod, haddock, redfish, Greenland halibut, and Barents Sea capelin were limited to quantities stipulated in Soviet-Norwegian agreements, and fishing quotas were set jointly for major species of fish in the EEC-Norwegian economic zones. Finally, the ban on fishing of winter herring and North Sea herring was extended through 1981.

The capelin fishery—increasing its position as the major supplier of raw fish material to the reduction industry—yielded 1,362,900 t in 1981, up 21.9 percent. Winter and summer fishing in the Barents Sea were regulated by quotas for individual vessels. About 96,000 t of the capelin were taken in the Jan Mayen area. Aggregate catches of herring and brisling were only 31,600 t (merely one-third of the 1980 total) due mainly to the Danish delay in signing the 1981 Norwegian-EEC fisheries agreement, which prevented Norwegian purse seiners from fishing North Sea brisling during the peak season at the beginning of the year. Of Norway's 71,000 t quota for such fish only 41 t were taken.

The mackerel catch, regulated by agreement with EEC and by national directives, was 62,900 t, down 18.2 percent from 1980. Catches of Norway pout, sandeel, and blue whiting (all currently used for reduction) were 86,100 t (down 33.5 percent), 51,600 t (down 65.2 percent) and 157,600 t (up 16.9 percent), respectively. The 1981 output in the fish reduction industry was 299,200 t of meal (up 0.6 percent) and 164,600 t of oil (down 9.1 percent).

Arctic Cod Quotas

Quotas for Arctic cod negotiated



for 1981 with the Soviet Union were 170,000 t for each nation, with permission to continue fishing with stationary gear (gill nets, longlines, and handlines) after the quota had been filled. However, because the major part of the cod, as well as the haddock, stayed in the Norwegian part of the Barents Sea and off the west coast of north Norway (i.e., in the Norwegian economic zone), Norwegian fishermen landed a total of 332,500 t in 1981, or 18.3 percent more than in 1980. The aggregate yield of other demersal fish was 379,700 t, up 6.2 percent. The most important of the latter were saithe, haddock, cusk, ling, and redfish. Production at Norway's 250 fish farms—most of which operate saltwater enclosures—amounted to 8,400 t of salmon and 4,500 t of rainbow trout, up fully 100 percent and 32.3 percent, respectively, over 1980.

The export value of fish and fish products increased 25 percent to $1.1 billion in 1981. The traditional products of stockfish and klippfish appear to have been the most successful in the export markets. Exports of stockfish increased 49.4 percent to $174 million, reflecting higher export volumes and prices particularly in the main markets of Italy and Nigeria. Exports of klippfish increased 27.8 percent to $167 million. Two-thirds of the increase was accounted for by sales to Portugal, Norway's second largest market for klippfish after Brazil. Exports of frozen fish fillet, for many years the major export fish product, rose 10.2 percent to $153 million. Exports to the United States, the second largest market for frozen fillets after the United Kingdom, increased 41.3 percent to $41.8 million in 1981. Total Norwegian exports of fish products to the United States were up 17.5 percent to $70.7 million in 1981. Norway's imports of fish and fish products from the United States were $5.8 million, compared with $2.0 million in 1980. Export volumes and values for major categories of fish and fish products are shown in Table 1.

Table 1. Norwegian exports of major fish products in 1980 and 1981, by volume (t) and value (million NKR).

Product	1980		1981	
	Metric tons	Million Kroner[1]	Metric tons	Million Kroner[1]
Herring, brisling, iced, frozen, including fillets	4,100	14.9	9,600	25.1
Other iced fish, including fillets	19,800	284.1	39,100	355.5
Other frozen fish, except fillets	57,900	274.7	62,700	317.5
Frozen fish fillets, except herring	65,800	765.6	72,000	843.3
Salted herring, except fillets	2,400	20.7	4,300	30.8
Other salted fish, including fillets	12,500	187.2	10,900	166.8
Stockfish	21,200	639.6	29,200	955.4
Klippfish	52,100	720.1	56,600	920.7
Crustaceans and mollusks	6,800	108.3	7,200	116.3
Fish oil	79,400	180.5	107,300	241.4
Cod liver oil	12,700	63.1	10,900	51.3
Canned fish	14,100	233.8	15,300	282.0
Semicanned fish	22,000	256.9	20,900	258.3
Semicanned crustaceans and mollusks	8,900	333.8	9,300	331.1
Fish meal	274,700	677.9	266,300	769.9

[1]US$1.00 = NKR 5.125 (1980) and NKR 5.50 (1981).

Fish Quotas for 1982

The 1982 fish quota agreement with the Soviet Union, as well as the results of the winter fisheries off the coast of north Norway, bode well for the fish processing industry's supplies of raw material. Of a TAC of 340,000 t, Norway was allocated 197,500 t, the

The Norwegian Fisheries

From 60 to 70 percent of the 3 million tons of fish which Norwegian fishermen harvest from the sea each year is caught around the Norwegian mainland, and from 15 to 20 percent is caught in the Svalbard zone; 2.5 percent is taken in the region of Jan Mayen.

But Norwegian boats also take plentiful amounts of the fisheries resources in the economic zones of other nations. From 10 to 15 percent of the total Norwegian catch is from such areas; 2 percent comes from beyond Norway's 200-mile limit in international waters.

Norway has fisheries agreements with a number of countries. Chief among these are agreements on mutual fishing rights with the EEC, Soviet Union, and the Faroes, as well as agreements ensuring fishing rights from Sweden and Finland in the Norwegian economic zone, and agreements giving East Germany, Poland, Portugal, and Spain the right to fish surplus stocks in the Norwegian zone.

In the region embracing the Skaggerak and the northern part of the Kattegat, Norway, Sweden, and Denmark have an agreement which is valid up to the year 2002. This grants fishermen from the three lands access to fish up to 4 n.mi. from the basic line in the area, regardless of zone demarcations. Regulatory measures in the area are based on agreements between the three nations. At present, the EEC negotiates on behalf of Denmark within the framework of the three-country agreement.

Norway currently has 30,000 fishermen: 16,000 are solely engaged in fishing, 6,000 are mainly engaged in fishing, and 9,000 state that it is a supplementary occupation. In the Norwegian fishing fleet there are 24,000 boats, 17,000 of the open variety. Half of the 3 million t catch consists of capelin, while the cod catch is 500,000 t. The first-hand value is $650 million and 90 percent of the fish goes to export, with the export value about $950 million.

Soviet Union 107,500 t, and third countries 35,000 t. Of a 110,000 t haddock TAC, Norway was allotted 75,000 t, the Soviet Union 25,000 t, and third countries 10,000 t. The Soviet Union was compensated for its reduced cod and haddock quotas (reflecting the current fish migration to Norwegian waters) with a 470,000 t blue whiting quota for 1982 (185,000 t in the Norwegian zone proper and the rest off Jan Mayen). In addition, the Soviet Union was allowed to catch 54,000 t of redfish (*Sebastes marinus*) and 2,400 t of Greenland halibut in the Norwegian zone. Of a 1.7 million t TAC of Barents Sea capelin, Norway was allowed 1,130,000 t.

Norway's fisheries agreement for 1982 with the EEC provided for a 2,600 t shrimp quota (down 35 percent) off Greenland. On the North Sea mackerel front, the 25,000 t TAC (down 37.5 percent), was reserved for Norway, except for 700 t for Sweden, due to EEC overfishing in 1982. In addition, Norway was allowed to fish 16,000 t (down 20 percent) of mackerel west of Great Britain. The mackerel fishing in the Norwegian zone north of the 62nd parallel was regulated by Norway in 1982. Fishing of North Sea herring was banned for 1982, but Norway was allotted 6,000 t (down 40 percent) of a 60,000 t TAC west of Great Britain. Norway was, moreover, permitted to catch 60,000 t of North Sea brisling (down 16.5 percent). In Norway's economic zone north of the 62nd parallel, EEC fishermen were allowed to fish 12,000 t (down 6.2 percent) of Arctic cod and 7,000 t (down 12.5 percent) of saithe in 1982. The French vetoed the EEC fishing agreement, but lifted the veto during the second week of 1982 following a Norwegian ban on EEC fishing in Norway's economic zone.

Government subsidies to the fisheries were stipulated at $175 million for 1982, or 7.7 percent less than in 1981. Price supports for the cod and herring fisheries were set at $122 million and the remaining $53 million were allotted for cost reduction and social measures. (Source: IFR-82/123.)

Norway Dissatisfied With EEC Fish Product Imports

Norway's 10-year old trade agreement with the EEC has been unsatisfactory for the export of Norwegian fisheries products, according to Norwegian authorities. Fresh negotiations with the EEC must be taken up as soon as possible, stated Wictor Sørensen of the Norwegian association of fisheries at a press conference late last year.

A Norwegian delegation has held talks with representatives of the EEC commission and Finn Bergesen of the Ministry of Fisheries stated that Norway had expressed dissatisfaction with the EEC's high tariffs for Norwegian fisheries products. This is especially the case for fresh fish, canned fish, fish meal, and fish oil, where the duty for certain products can reach 20 percent. Other countries have reportedly been given better conditions than Norway in the period following Norway's trade agreement with the EEC in 1972. The high tariffs are also an impediment to the further development of Norwegian fisheries products that were not included in the 1972 agreement, it was asserted at the press conference. (Source: Norinform.)

Better Times Foreseen for Norwegian Fishermen

Many years of regulated fisheries quotas in Norway are starting to have an effect, and in a year or two Norwegian fishermen can reap the results, says State Secretary Leiv Grønnevet in the Ministry of Fisheries. In recent years Norwegian fisheries have been characterized by pessimism, cutbacks, and the results of empty, overfished waters.

In a few years, the reserves of five or six types of fish will be on the way up again—fish which are of real significance for Norway, Grønnevet predicts. In 1982, the Arctic cod has reportedly shown excellent growth conditions on account of the large amounts of warm water which have flowed into the Barents Sea from the Atlantic Ocean. This gives the fry a good chance of survival. The final results of these improved conditions are expected to be evident in about 5 years. As for herring, things are moving much faster. In the middle 1980's it will be possible to reap the results of the anticipated buildup of herring reserves, says Grønnevet. The picture is even brighter for capelin. It has been carefully observed that fishing can be increased in 1983 and 1984. Also, the outlook is finally improving for important species such as saithe, mackerel, and haddock. However, the authorities will impose strict regulation of Arctic cod fisheries in 1983. In 1982 the quota will be about 320,000 t, but the figures must be reduced by about 100,000 t for 1983. This implies a loss of raw material with a first-hand value of about US$43 million. (Source: Norinform.)

Norway and Russia Sign Fish Agreement

Norway and the Soviet Union have signed a fisheries agreement for 1983 involving quotas in the Barents Sea which essentially follows the 1982 recommendations and agreements from scientists. From most of the species of fish the agreement is as set out in the following table (the data are in thousands of tonnes). (Source: Norinform.)

Norwegian-USSR fishery quotas for 1983.

Species	Total catch		Norway		USSR	Third country
Arcto-Norw. cod	260		152		152	
Norw. coastal cod	40	+	72.5	–	72.5	
Murmansk cod	40					
Total	340		225		80	35
Capelin	2,300		60%		40%	
Haddock	77		35		35	7
		+	20	–	20	
Total			55		15	
Blue whiting					[1]200	
Blue whiting					[2]285	
Greenl. halibut	13		7.5		5.5	
Redfish					[1]70	
Octopus					[1]5	

[1]In the Norwegian economic zone.
[2]In the fisheries zone around Svalbard.

Japan's 1981 Fisheries Production Hits New High

Japan's annual landings of fisheries and fish culture products for 1981 set a new record, aided by a record-setting performance by the offshore fisheries and improved catches by the coastal fisheries, according to the statistics released by the Ministry of Agriculture, Forestry, and Fisheries. The total catch for the year was 11,319,000 metric tons (t), a 2 percent gain over the previous high of 11,122,000 t in 1980.

By species, significant gains were recorded in the catches of sardine (+37 percent), dolphin fish (+23 percent), and salmon (+22 percent), whereas sharp declines occurred in common squid (−41 percent), cuttlefish (−32 percent), and mackerel (−30 percent).

The most important species landed in terms of quantity was sardine, as in 1978, 1979, and 1980, with a catch of 3,339,182 t, followed by Alaska pollock with 1,595,302 t (+3 percent). The third in importance was mackerel, which, at 908,015 t, showed a decrease of 30 percent over 1980. Sardine, Alaska pollock, and mackerel together accounted for 58 percent of the total Japanese marine catch for 1981. The landings by major fisheries and species are shown in Tables 1 and 2.

Table 1.—Japan's fisheries catch by type of fisheries, 1979-81.

Type of fisheries	Catch (1,000 t) 1979	1980	1981	1981/1980 (%)
Marine fisheries				
Distant-water	2,066	2,167	2,160	100
Offshore	5,458	5,705	5,938	104
Coastal	1,953	2,037	2,045	100
Marine culture	883	992	960	97
Inland fisheries	136	128	124	97
Inland culture	95	94	92	98
Total	10,590	11,122	11,319	102

Table 2.—Japan's marine fisheries catch by selected species, 1980-81.

Species	Catch (t) 1980	1981	Species	Catch (t) 1980	1981
Tuna			Cod		
Bluefin	49,494	58,485	Cod	96,742	102,205
Albacore	69,677	64,082	Alaska pollock	1,552,421	1,595,302
Bigeye	123,168	110,513	Total	1,649,163	1,697,507
Yellowfin, large	119,001	110,008			
Yellowfin, small	17,156	17,190			
Total	378,496	360,278	Atka mackerel	117,351	122,839
			Rockfish	31,310	27,776
Skipjack			Croaker	32,025	33,358
Skipjack	354,156	289,286	Hairtail	37,803	35,097
Frigate mackerel	22,582	16,205	Sea bream	28,151	26,567
Total	376,738	305,491	Spanish mackerel	7,045	6,181
			Dolphin fish	10,280	12,683
Billfish	44,122	47,455	Flying fish	7,690	9,097
Shark	42,286	36,978	Sandlance	201,209	162,448
Salmon	122,515	149,845	Shrimp	50,505	54,048
Herring	11,154	8,901	Crab	77,559	76,227
Sardine	2,441,961	3,339,182	Common squid	331,225	196,830
Jack mackerel	144,979	122,231	Cuttlefish	10,409	7,072
Mackerel	1,301,122	908,015	Other squid	343,740	312,598
Saury	187,155	160,319	Octopus	46,106	52,236
Yellowtail	42,009	37,774	Sea urchin	24,158	23,984
Flatfish	288,881	296,572	Shellfish	337,885	355,128

Mozambican Fishing Fleet Set for Rehabilitation

The Mozambican Fishing Company (Emopesca) was created in 1977 by the Mozambican Government as the state fishing company. Emopesca had a fleet of 36 fishing vessels and 1,300 employees in early 1982. The company's fleet had a total productive capacity of 3,500 metric tons per year or about 10 percent of Mozambique's total annual catch. The vessels operate from ports in Angoche, Beira, and Quelimane. Emopesca's catch, mostly shrimp, is exported to France, Japan, Portugal, Spain, and other countries through the state marketing company Pescom International.

Emopesca has suffered a series of recent setbacks that have sharply impaired its operations. Twelve of Emopesca's 36 vessels (one-third of its fleet) have either sunk or are not currently operational. Emopesca has had difficulty maintaining its fleet for some time. Five of the company's vessels were not operational in early 1982 because of poor maintenance. Between 21 and 23 March 1982, another five vessels were lost as a result of tropical storm Justine. Two of these five vessels ran aground during the storm on Premeira Island off north-central Mozambique. Eight crew members were killed in this accident. Three other Emopesca trawlers were lost during the storm and are believed to have sunk in the Mozambique Channel. All 66 crew members from these three vessels are presumed dead. In addition to the five vessels lost during tropical storm Justine, two Emopesca trawlers sank while docked in the port of Beira in March 1982. The cause of the sinking has not yet been determined, but both vessels were considered recoverable.

The Mozambican Government had placed a high priority on rehabilitating Emopesca's fleet, even before the recent losses. Most of the company's vessels, even those which were operational, were reportedly in poor repair because of inadequate maintenance and a lack of trained personnel. The Government contracted with the Portuguese fishing company Sentenave in 1981 to help expand Emopesca's fleet and to modernize its equipment. A U.S. bank reportedly may loan Emopesca $1.6 million to help finance some of Sentenave's Mozambique projects.
(Source: IFR-82/67.)

The French Fishing Fleet Modernization Program

The French Ministry of Ocean Affairs (Ministere de la Mer) has drafted a 5-year, $370 million investment program (1982-86) to modernize the country's fishing fleet (Table 1). The plan is designed to modernize both the commercial fleet (consisting of the middle-distance fleet, the high-seas fleet, and the tuna fleet) and the artisanal fleet which operates along the country's coast. Outdated and unproductive vessels will be replaced.

Table 1.—Proposed cost of the French fishing fleet modernization program, 1982-86.

Item	Cost (US$10^6)
Vessels	
Commercial fleet	
Middle-distance	94.4
High-seas	26.4
Tuna seiners	71.4
Artisanal	170.0
Total, vessels	362.2
Landing facilities	5.7
Grand total	367.9

The Government will finance the program through grants and low-interest loans to the fishermen. The grants for the commercial fleet must first be approved by an administrative commission composed of representatives of the French Ministries of Finance and Ocean Affairs. Assistance to the coastal fleet will be approved by a new regional administrative commission (the Groupement Regional d'Investissement a la Peche Artisanale —GRIPA). The Ministry of Ocean Affairs prepared the investment program in close cooperation with the fishing industry, which is reportedly pleased with the plans. The Government was expected to approve the program before the end of 1982. If so, the construction of commercial vessels could begin as early as 1983. The program to aid artisanal fishermen will probably not begin until 1984. The French Government is decentralizing its administration, and the establishment of the regional administrative commission, which will administer the artisanal fleet plan, is part of this program. As a result, assistance to artisanal fishermen cannot begin until the commission is appointed and begins functioning.

Commercial Fishing Fleet

The proposed program includes separate provisions for all three sectors of the commercial fishing fleet. The investment program for the middle-distance fleet covers trawlers fishing in the North Sea and around the United Kingdom. Middle distance fishermen land fresh fish after trips of about 12 days. The plan provides for the construction of over 60 new vessels. The Government has allotted US$23 million (FF160 million)[1] to build seven vessels over 40 m long. These seven vessels will be based in the port of Boulogne, and in other ports along the northern coast of France. The Government has allotted over $70 million to build from 53 to 58 new middle-distance trawlers less than 40 m long. These smaller vessels will be based in ports located in Brittany (40-45 vessels) and along the English Channel (7 vessels) and at the port of La Rochelle (5 vessels).

The high-seas fleet currently includes freezer trawlers fishing off Canada, Norway, and the Kerguelen Islands. The Government plans to finance the construction of four new vessels, costing an estimated $26.4 million. The Government also plans to finance the construction of 12 tuna seiners which will also cost over $70 million. These vessels will fish mainly off Western Africa and in the Indian Ocean. And, an additional $5.7 million will be budgeted to modernize the unloading facilities in French fishing ports.

The French Government will finance the program for the commercial fleet through a combination of grants and loans. Government assist-

[1]French francs were converted at the exchange rate prevailing on 12 August 1982 which was 7.00 French francs = US$1.00.

ance is available for the construction of new vessels, and the modernization of existing vessels and equipment. The loans will apply to a portion of the investment cost which is not covered by the grants.

The Government grants to commercial fishermen will cover 12-35 percent of the projects planned by the modernization program. The Government will offer a grant covering 20 percent of the cost of new trawlers. In addition, the Government will offer grants of 20-35 percent of the cost for new freezing and processing equipment aboard trawlers. Other grants will cover 12.5 percent of the construction costs for new tuna seiners. The Government also plans to offer grants covering 12-20 percent of the cost of modernizing existing vessels (Table 2). The exact percentage will depend upon the prevailing interest rate and the need for the investment.

The Government also plans to provide low-interest loans to commercial fishermen to finance 60 percent of the costs not covered by the grants. These loans will have interest rates of 8 percent and are repayable in 8½ years.

Artisanal Fishing Fleet

The French Government plans to finance the construction of 470-500 coastal fishing vessels over 12 m long. The Government projects that 215-225 of these vessels will be based in ports in Brittany, 70-80 in Normandy (Port en Bessin), and 165 to 185 in other French ports. The total cost of these vessels could exceed $170 million.

The Government also plans to finance investments in the artisanal fleet through grants and loans. The grants will range from 10 to 20 percent of the cost of the new vessels. The basic grant of 10 percent will finance the construction of the vessels. An additional 5 percent may be allocated if the fisherman who buys the vessel is a new entrant in the fishery. Depending on the need for the project, another grant of up to 5 percent may be offered. The total grant may thus be as high as 20 percent of the construction costs (Table 2).

Table 2.—France's fishing fleet modernization program, 1982-86.

Type	Vessels: Number	Vessels: Cost ($US10[6])	Grant coverage[1]	Interest rates for: New vessels	Interest rates for: Used vessels
Commercial fleet					
Trawlers			[2]20.0%	8%	NA
Middle distance	60	94.4			
High-seas	4	26.4			
Tuna seiners	12	71.4	12.5	8	NA
Total	76	192.2			
Artisanal	470-500	170.0	[3]10.0	5	11%
Total	546-576	362.2	NA[4]	NA	NA

[1]Portion of the vessel's construction cost covered by the grant.
[2]The Government is also offering grants covering 20-35 percent of the equipment cost on new vessels and 12-20 percent for the modernization of existing (used) vessels.
[3]An additional 5 percent grant may be allocated if the fisherman is a new entrant in the fishery plus another 5 percent depending on the need for the project.
[4]NA = not applicable.

The Government will offer loans to finance the investment costs not covered by the grants, at interest rates between 5 and 11 percent, repayable in 9-12 years. The loans will be granted by the Credit Maritime Mutual, a Government agency which supervises all maritime credit organizations. If the fisherman is entering the fishing profession for the first time, the loan will apply to about 90 percent of the investment costs not covered by the grants. If the fisherman buys a new fishing vessel over 12 m long, the loan will be at an interest rate of 5 percent, repayable in 9 years. If the fisherman buys a used vessel the interest rate will reach 11 percent, repayable in 12 years. If the fisherman is not a new entrant in the fishery, the loans will only apply to 66 percent of the portion of the total investment costs which are not covered by the grants. (Source: IFR-82/129.)

Latin American Nations to Develop Fish Products

Six Latin American countries (Cuba, Ecuador, El Salvador, Mexico, Panama, and Peru) signed an agreement in Lima, Peru, on 6 September 1982 to cooperatively develop low-cost fishery products. The countries are seeking to increase supplies of pastes, cakes, sausages, dried products, and other commodities to low-income consumers. The countries agreed to establish a committee that will be chaired by Salvador Carrion of the Peruvian Ministry of Fisheries. The meeting was organized by the Sistema Economico Latino-Americano (SELA), an organization which coordinates economic policies of Latin American countries. (Source: IFR-82/132.)

U.K. Salmon Farms Expected to Grow

Farmed salmon production in the United Kingdom was 1,133 t in 1981, compared with just 598 t in 1980. UK salmon farmers expect production to increase to as much as 5,000 t by 1985. Currently, UK salmon is farmed in approximately 30 sites, but primarily in Scotland. The 1981 salmon production marks the first year that the United Kingdom has produced more Atlantic salmon from farms than its fishermen landed. (Source: IFR-82/97.)

New Zealand Seeks To Limit Fishing

New Zealand's Acting Minister of Fisheries and Agriculture announced early last year a temporary "limited entry" system for inshore fishermen. Talbot stated that no new licenses will be issued to fishermen desiring to enter inshore fisheries. This temporary measure was taken to reduce the effects of increased fishing effort on New Zealand's inshore fishery stocks.

Many observers believe that a permanent reduction in inshore fishing is needed. In response to this situation, the Commercial Fishermen's Federation adopted an Inshore Fishery Effort Reduction Scheme (ERS) at its May 1982 annual meeting. The ERS is designed to reduce inshore fishing by 50 percent. The details of the Federation's plan follow.

Effort in the inshore fishery would be reduced in three ways. First, all part-time fishermen would lose their licenses and would not be compensated for the loss. Their total effort up until the introduction of the ERS would be noted and deducted from the 50 percent reduction target.

Secondly, the larger, recently imported vessels would be exempted from the ERS provided they did not operate in the inshore fishery. The Government would have to improve the economic climate under which these vessels operated and offer them access to offshore fishery stocks as free from competition as possible. Third, and simultaneously with the above two provisions, volunteers from the remaining full-time inshore fishermen would opt out of the fishery. Volunteers' vessels would be appraised at a "fair" value—not a replacement or insured value. The vessels would then be deregistered and offered for sale on the open market. The difference between the amount realized and the appraised value would be paid to the owners from the ERS fund. All fishermen who volunteered to leave the fishery would be required to sign a covenant that they would not attempt to re-enter the fishery as license holders.

The ERS would be funded from two different sources. Administration costs, implementation, and appraisals could be funded by a direct charge to the fishermen, such as an increased license fee. This charge would cease when the ERS ended. And, the cost of reimbursement of the difference between the realized and appraised value of the vessels would be funded by a Reserve Bank loan to the industry at 1 percent interest ("the same interest rate extended to primary industry in the past"). This would be repaid by a levy on all fish landed by the remaining license holders and collected by a suitable government agency. The levy could be a fixed national rate and would be assessed on the basis of the quantities landed, not the value of the landings. For levy collection to be fair, all wet fish would have to be sold to accredited wholesalers or processing plants. (Source: IFR-82/110.)

New Zealand Fish Board Promotes Development

The New Zealand Fishing Industry Board (NZFIB) was created by an Act of Parliament in 1963 to promote the development of the country's fisheries. It provides technical assistance to the fishing industry and also acts as a liaison between the New Zealand Government and the industry.

The NZFIB is governed by an eight-member board of directors. Government officials appoint three board members. A Chairman and a second board member are appointed by the Minister of Fisheries and Agriculture. The Director General of the Ministry of Fisheries and Agriculture, or his representative, is also a member of the Board. Fishery organizations elect five other board members: Two fishermen, two fish processors, and one fish retailer.

The NZFIB is run by a General Manager who is responsible for its five divisions and a special group of training consultants. The organizational breakdown of the NZFIB is outlined in Figure 1. The NZFIB employs a staff of 37 in its Wellington offices and works closely with two training advisors from the Fishing Industry Training Council.

The NZFIB's principal mission is to promote the development of the country's fishing industry. The Board provides technical assistance and training to the industry and represents the industry in seeking Government support. The NZFIB's principal projects currently include fishing technology, aquaculture, processing, marketing assistance, economic analyses, and training.

Under fishing technology, the NZFIB advises and encourages the industry to explore fishing methods that

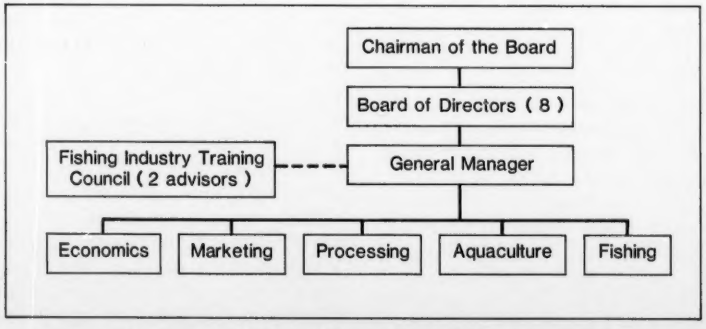


Figure 1.—Organization of the New Zealand Fishing Industry Board.

will help exploit underutilized species more effectively or make current operations more efficient. In aquaculture, the NZFIB encourages and provides technical assistance to marine and freshwater fish and shellfish culturists. The NZFIB also assists processors with seminars, codes of practice, and technical advice on how to produce high-quality products and thus maintain a good reputation for New Zealand fishery products.

For marketing assistance, the NZFIB provides comprehensive marketing information and assistance for industry organizations to expand existing foreign markets and develop new ones. The Board also monitors economic conditions in the industry and submits recommendations to the Government for needed governmental actions to support the industry. Dissemination of new technology and other developments is achieved through a variety of training programs and the NZFIB assists the Fishing Industry Training Council with programs designed for each sector of the industry.

The Board is partially funded by a levy on fishery landings and is also supported by a grant from the Government. The levy rate for Fiscal Year 1980 (April 1980-March 1981) was 0.8 percent of the landed value for lobster and 0.9 percent for finfish. In FY 1980, the levies provided NZ$0.9 million and the Government contributed NZ$0.2 million for a total income of NZ$1.1 million (US$1.2 million)[1]. Operating capital expenses of the NZFIB in FY 1980, however, exceeded projected income by NZ$0.2 million; it is not known how this deficit was financed.

European Lobster Markets Reviewed

In the last decade, total European lobster landings have remained fairly static at under 4 million pounds a year, while Canadian and U.S. landings have continued to increase and are presently at over 80 million pounds a year. The static European landings are generally accepted to be due to overfishing.

In May 1981, to combat this overfishing, the British (who traditionally land almost half of all European lobsters) increased the legal minimum landing size from 80 to 83 mm (carapace length) and intend to raise it again to 85 mm in May 1983. Such measures are expected to result in lower landings for several years to come.

Since European landings are small, the European lobster generally sells throughout the year for 200-400 percent (ex-vessel) more than North American lobster. European importers found Canadian lobsters are often better packed and that larger quantities of similar-sized lobster are available for less than half the price of European lobster.

Canada exports lobster to the U.S. market mainly when low supplies in the United States mean higher prices. This is traditionally the April-July period when Canadian exports of live lobster to the United States are the heaviest. However, on the European market, demand for lobster is highest towards the end of the year (October-December) in time for the peak consumption period at Christmas. In this time period, lobster from the United Kingdom and Ireland are in short supply and expensive. Apart from the United Kingdom and Ireland, only France has any significant domestic lobster production, but all three countries still find it necessary to import considerable quantities.

France is the largest market for lobster in Europe and imports of live lobster grew by 66 percent between 1976 and 1980. In 1980, over 2,572,750 pounds of live lobster were imported to supplement French domestic production of just over 700,000 pounds. Preliminary figures for the first 11 months of 1981 showed lobster imports 19 percent above 1980 figures. As with the European market in general, demand peaks in the Christmas period with over half of all imports occurring in the last quarter of the year.

Although Belgium imports less lobster than France, Belgian per capita consumption is higher. Accurate figures are only available through the end of 1979 when 2,645,500 pounds of live and whole frozen lobster were imported. The United Kingdom was the major supplier of live lobster into Belgium until 1978 when Canadian exports grew in importance. The Belgian market imports very large quantities of live lobster in December for the Christmas gourmet market. Consumption has been reduced somewhat since July 1980 when the Belgian government increased the Value Added Tax on lobster to 25 percent.

Between 1970 and 1980, British landings of lobster declined by 33 percent, and as discussed, this decline is expected to continue due to the new minimum legal landing size enacted. In the 5-year period 1976-80, imports of live lobster rose by 65 percent to 300,000 pounds while imports of frozen whole lobster increased by 74 percent to 265,000 pounds. This trend is expected to continue even with the new licensing requirements imposed on British importers in August 1981. The new law was enacted to protect British lobster stocks from gaffkaemia.

West German imports of live lobster have increased by 300 percent from 1976 to 1980, but still only totaled 831,000 pounds in 1980. Again December is the peak consumption period with over 25 percent of total yearly imports occurring during this month.

Although the Netherlands is a significant importer of live lobster (1,516,750 pounds in 1980), most of this is reexported to Belgium and France. The Dutch have put greater effort into selling lobster in their own country in the last 2 years as their reexport markets have begun to see the advantage of importing directly from Canada. Data from 1980 indicate apparent domestic consumption by the Dutch of just over 600,000 pounds of imported lobster.

[1]The exchange rate on 31 December 1980 was NZ$0.95 per US$1.00.

New NMFS Scientific Reports Published

The publications listed below may be obtained from either the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402; from D812, Publication Services Branch, Information Management Division, Environmental Science Information Center, NOAA, Rockville, MD 20852; or from the National Technical Information Service, Springfield, VA 22151. Writing to the agency prior to ordering is advisable to determine availability and price, where appropriate (prices may change and prepayment is required).

NOAA Technical Report NMFS Circular 444. Leatherwood, Stephen, Randall R. Reeves, William F. Perrin, and William E. Evans. **"Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters. A guide to their identification."** July 1982, 245 p.

ABSTRACT

This field guide is designed to permit observers to identify the cetaceans (whales, dolphins, and porpoises) they see in the waters of the eastern North Pacific, including the Gulf of California, Hawaii, and the western Arctic of North America. The animals described are grouped not by scientific relationships but by similarities in appearance in the field. Photographs of the animals in their natural environment are the main aids to identification. Appendices describe how and to whom to report data on live and dead cetaceans and provide information to aid in identification of stranded cetaceans.

NOAA Technical Report NMFS Circular 445. Garrick, J. A. F. **"Sharks of the genus *Carcharhinus*."** May 1982, 194 p.

ABSTRACT

The genus *Carcharhinus* Blainville contains 25 living species of whaler sharks, one of which (*C. wheeleri*) is described as new while the other 24 incorporate 95 identifiable nominal species which fall into the limits of the genus as here recognized. Features studied include morphometrics, external morphology, color, tooth numbers and shapes, vertebral numbers and other vertebral characteristics, and biological data. The systematic value of these features is reviewed, and it is concluded that despite their importance at the specific level they do not in general allow firm statements on subgeneric groupings or on the relationship between *Carcharhinus* and other similar genera. Accordingly, no formal subdivision of the genus is proposed, and the limits and characterization of the genus are essentially as in Bigelow and Schroeder (1948) except that the following six nominal species are excluded because of one or more notably divergent aspects of their morphology: *Carcharias gangeticus* Müller and Henle, *C. glyphis* M. and H., *C. oxyrhynchus* M. and H., *C. temminckii* M. and H., *Carcharhinus tephrodes* Fowler, and *Carcharinus velox* Gilbert. A further 13 nominal species are treated as species dubia.

Long-established names for two species, *Carcharhinus limbatus* Valenciennes and *C. sorrah* Val., are retained though each has a poorly founded senior synonym; their cases must be put to the International Commission of Zoological Nomenclature. A neotype is designated for *brachyurus* Günther, and lectotypes are designated for *dussumieri* Val., *henlei* Val., *malabaricus* Day, *menisorrah* Val., *pleurotaenia* Bleeker, *sorrah* Val., and *tjutjot* Bleeker.

A key is given to differentiate the species. For each species primary synonyms are listed and discussed and a diagnosis and description are given. Descriptions include measurements and counts and line illustrations that show the whole shark in lateral view, underside of head, nostril, and teeth. The geographic distribution is described, and biological data on number of embryos, size at birth, size at sexual maturity, and maximum size are summarized.

Seals, Humans, and Resource Management

"Seals and Man," subtitled "A Study of Interactions" and published by the Washington Sea Grant program explores an often controversial topic: Pinniped exploitation. Author W. Nigel Bonner, who has extensively studied seals in both northern and southern seas, currently heads the Life Sciences Division of the British Antarctic Survey.

Beginning with an overview of the pinnipedia and their physical adaptations to the marine environment, the author then provides a historical look at the human-seal interactions, beginning with early archaeological data on hunting by European and Eskimo cultures. He then provides concise, chapter-by-chapter reviews of the biology, numbers, and harvests of northern seals (harp and northern fur seals), fur seals of the southern hemisphere, southern elephant seal, and the relatively unexploited Antarctic (Weddell, crabeater, leopard, and Ross) seals. Details are also provided on the exploitation and management of those seals.

One chapter is devoted to seal and fisheries interactions, i.e., damage to fishing gear, consumption of fish by seals, seals as parasite (i.e., codworm and other anisakine nematodes) hosts, and measures used to control seals. Another chapter reviews the problem of the gray seal in the United Kingdom where a variety of harvesting, conservation, and protection measures have been tried. A final chapter discusses such indirect human impacts on seals as fishing net mortality; harvesting of fishes used as food by seals; pollution; disturbances by sightseers, oil exploration, boat traffic, etc.; and where either a food supply (i.e., krill) or habitat has improved for some species.

Amply illustrated (64 figures, 10 tables) and indexed, the 170-page paperbound volume presents a good, concise overview of human and seal relationships. It is available from the University of Washington Press, Seattle, WA 98105 for $9.95.

The 25 species are predominantly tropical-subtropical, but only two appear to be confined to the tropics and seven have been recorded from the tropics to latitudes as high as 40°. Most are coastal, one is virtually insular, and one, or perhaps two, enter fresh or brackish water. Eight species are worldwide; 23 occur in the Indo-Pacific, 13 in the western Atlantic, 11 in the eastern Atlantic, 10 in the eastern Pacific, and 5 in the Mediterranean.

NOAA Technical Report NMFS Circular 446. Taylor, Ronald M. **"Marine flora and fauna of the northeastern United States. Lichens (Ascomycetes) of the intertidal region."** August 1982, 26 p.

ABSTRACT

This manual treats the lichens found in the intertidal region from New Jersey to Newfoundland. Methods of collection, preparation, and study are briefly treated. Twenty-two species are covered, both in an illustrated key and an alphabetical listing, with brief descriptions and notes on ecology and distribution. A glossary of terms is included.

NOAA Technical Report NMFS Circular 447. Shaw, William N. (editor). **"Proceedings of the Eighth U.S.-Japan Meeting on Aquaculture at Bellingham, Washington, October 17-18, 1979."** November 1982, iii + 25 p. (5 papers.)

NOAA Technical Report NMFS SSRF-757. Wenner, Elizabeth Lewis, Malcolm H. Shealy, Jr., and Paul A. Sandifer. **"A profile of the fish and decapod crustacean community in a South Carolina estuarine system prior to flow alteration."** March 1982, iii + 17 p., 8 figs., 5 tables.

ABSTRACT

The seasonal distribution and abundance of fishes and decapod Crustacea collected by 6 m otter trawl from the North and South Santee Rivers, South Carolina, were examined over a 2-year sampling period. Species richness was greatest during summer and at stations located in proximity to the river mouths. Although species richness was found to be related to salinity, temperature, depth, and dissolved oxygen, it was most noticeably affected by a spring freshet which considerably lowered richness and abundance.

Eleven species accounted for 93 percent of the number and ~70 percent of the total fish biomass taken in both rivers: *Micropogonias undulatus*, *Anchoa mitchilli*, *Bairdiella chrysoura*, *Stellifer lanceolatus*, *Ictalurus catus*, *Cynoscion regalis*, *Dorosoma petenense*, *Leiostomus xanthurus*, *Trinectes maculatus*, *Brevoortia tyrannus*, and *Symphurus plagiusa*. White shrimp, *Penaeus setiferus*; brown shrimp, *P. aztecus*; and blue crabs, *Callinectes sapidus*, comprised over 96 percent by number and weight of the decapod fauna collected in both rivers. Dominant fishes were present in fairly equal abundance throughout the year and utilized the Santee system as either a residential or nursery area, while *P. setiferus* and *P. aztecus* were more seasonal in their pattern of appearance and abundance.

Length-frequency analysis showed the Santee system fish fauna to be composed mostly of juvenile specimens. Their presence throughout the year indicated that the Santee is a temporally stable and relatively non-stressed system and an important nursery area.

The predominance of juveniles accounted for lower biomass (kg/ha) of fishes in the Santee system compared to values for other estuaries along the Atlantic coast of the United States. The continued importance of juvenile fishes and shrimp in the Santee system is questionable in view of salinity changes in the nursery habitat following proposed river rediversion.

NOAA Technical Report NMFS SSRF-758. Gentry, Roger L., and John R. Holt. **"Equipment and techniques for handling northern fur seals."** July 1982. 15 p.

ABSTRACT

This paper describes techniques for capturing, immobilizing, and marking northern fur seals, *Callorhinus ursinus*, of all ages and both sexes. It is intended as an explicit field manual for handling this species, and as a source of ideas for handling other eared seals, wild or captive. Furthermore, it advocates capturing and manipulating wild seals as an approach to investigating behavior. The paper deals only with short term physical restraint; immobilization with drugs is not considered. Emphasis is placed on the importance of animal behavior in determining the design of capture equipment and techniques. Because of this dependence, capture techniques must change seasonally as behavior changes, and different techniques may be needed for different species. A wide range of techniques is considered,

Aquaculture and the Law

Publication of **"Aquaculture: The Legal Framework,"** by Bruce H. Wildsmith, announced by Emond-Montgomery Ltd., Canadian Law Publishers, 12 Mercer Street, 2nd Floor, Toronto, Ontario, Canada M5V 1H3, is the first book published in Canada on the legal and policy aspects of fish culture. The author is associate professor, Faculty of Law, Dalhousie University.

The volume sprang from the preparation of a model provincial law to promote and regulate aquaculture in Nova Scotia. The author was project leader for the effort and the result is presented as Appendix A. The project necessarily dealt with historic rights to fish, fishing, waters and submerged lands, etc., and this material forms the basis for the book.

The text examines common law as well as statutory material from around the world to set the stage for a thorough rundown on Canadian Federal and Provincial laws affecting aquaculture. Information is also presented on non-Canadian aquaculture legislation, such as a sample aquaculture lease from the State of Florida (Appendix 4).

Following a brief introduction, chapter 2 discusses such international aspects as the Law of the Sea conference, fisheries treaties, and the role of the FAO in aquaculture promotion. Chapter 3 presents a look at constitutional aspects affecting fisheries and aquaculture, and chapter 4 examines private property and public rights of aquaculturists, fishermen, land owners, etc. Risks and incentives in fish culture are detailed in chapter 5 (i.e., pollution problems, insurance, and disease from legal, administrative, and policy views).

Chapter 6 looks at aquaculture leasing, and chapter 7 provides a rundown on Canadian legislative provisions and practices concerning aquaculture. Finally, chapter 8 presents an in-depth review of the comprehensive Nova Scotia aquaculture act (printed as Appendix A). Appendix B lists sources of aquaculture information; and Appendix C presents a sample aquaculture insurance policy.

Indexed and with a lengthy bibliography, the 313 page hardbound book is available from the publisher for $45.

from the capture of single pups to the mass captures of adult females.

NOAA Technical Report NMFS SRRF-759. Squire, James L., Jr. **"Catch temperatures for some important marine species off California."** August 1982, 19 p.

ABSTRACT

Airborne sea surface temperature surveys using infrared techniques were conducted monthly off the central and southern California coast, 1963 through 1968, by the National Marine Fisheries Service in cooperation with the U.S. Coast Guard. The resulting temperature data were matched to commercial sportfishing boat catch data to determine the relationship between catch and temperature for the following major sport species: Chinook and silver salmon, *Oncorhynchus tshawytscha* and *O. kisutch*; yellowtail, *Seriola dorsalis*; Pacific bonito, *Sarda chiliensis*; Pacific barracuda, *Sphyraena argentea*; white seabass, *Atractoscion nobilis*; and albacore, *Thunnus alalunga*.

Part I presents graphs for each of the above species for areas having high catches, the month during which most fish were caught, sea surface temperature at which most fish were caught, mean catch temperature and its standard deviation, and temperature range.

Part II describes how catch and catch-per-unit-effort (CPUE) are related to temperature. A series of weekly airborne temperature surveys were flown over a high catch rate area off San Diego, Calif., April through October, in 1972, 1973, and 1974. These temperature data were compared with catches of yellowtail, Pacific barracuda, and Pacific bonito by the sportfishing fleet within the survey area. Graphical Kolmogorov-Smirnov cumulative preference curves of catch versus temperature for yellowtail, Pacific barracuda, and Pacific bonito show increased catch rates through the midrange temperatures 17.8° to 20.0°C (64° to 68°F) with a reduction in rates above 20.5°C (69°F).

For a 31-week period starting on 1 April 1972, 1973, and 1974, the temperature at the 20th percentile of the catch temperature curve was slightly above the 20th percentile of the cumulative temperature curve, indicating that fewer fish were taken at the very lowest temperatures; otherwise, catch for the three species appears representative of the temperature distribution. The average yearly temperature for large catches of Pacific barracuda, yellowtail, and Pacific bonito (30 percent or more above mean) fluctuated from 16.2°C (61.2°F) to 23.0°C (73.5°F), with a mean value of 19.5°C (67.1°F) for Pacific barracuda, 18.5°C (65.4°F) for yellowtail, and 19.6°C (67.4°F) for Pacific bonito. Nonparametric rank correlation tests (Spearman and Kendall) for catch and CPUE versus temperature showed consistently higher correlations for catch than for CPUE, indicating an increase in effort with increasing catch. In analyses of temperature and CPUE by species and year for 12-, 17-, and 31-week periods, about one-half of the individual cases tested were, on the average, statistically significant at the 0.05 level.

Temperature distributions within 20th percentile ranges of the cumulative CPUE curves obtained for the three species combined indicate that the lowest temperature range, 12.7° to 15.5°C (55° to 60°F), is the only area where catch rates were lower than expected.

There is little evidence for a preferred temperature within the range of 15.5° to 21.1°C (60° to 70°F). Conclusions from this study indicate that fishery data are by no means optimal for examining the hypothesis of preferred temperature, due to confounding of the cause and effect between catch and effort. Lack of simultaneous observation of the spatial distribution of species and environmental measurements over the extent of distribution over time are limiting factors in determining the true relationship of species to the environmental factor of sea surface temperature.

NOAA Technical Report NMFS SSRF-760. Moles, Adam. **"Parasite-host records of Alaskan fishes."** September 1982, 41 p.

ABSTRACT

This report summarizes the published records of parasites of freshwater and coastal marine fishes of Alaska through 1980. The report is organized both by parasite and by host, is cross-referenced, and provides a convenient, single source of information on parasites of Alaskan fishes.

How to Export U.S. Fish Products to Japan

The U.S. Embassy in Tokyo, Japan, has prepared a 43-page handbook entitled **"Exporting U.S. Fishery Products to Japan."** The booklet includes background information on the Japanese fisheries market and suggested business practices, types of packaging, financing, and shipping. Also included in the handbook as appendices are lists of import quotas, tariff rates, Japanese names for fish and shellfish species, and business contacts.

U.S. companies can obtain a copy of the report for $5 by requesting report number ITA-82-11-029 from NTIS, the National Technical Information Service, Department of Commerce, Springfield, VA 22161.

In addition, the NMFS and the Gulf and South Atlantic Fisheries Development Foundation conducted a seafood trade mission to Japan in March 1982 to assess the market for fish caught in the Gulf of Mexico and the South Atlantic. Fishery exhibitions were held in Tokyo, Kobe, and Fukuoka, and NMFS International Trade Specialist E. Moret Smith has prepared a 51-page report on the exhibitions with pertinent information on exporting U.S. fishery products to Japan.

The first section includes information on Japanese wholesale markets, major Japanese wholesale purchasers, Japanese packaging methods, and Japanese agents for U.S. exporters. The second section includes information on marketing and sales prospects in Japan for individual species and products. Species and products included in the second section are: Crevalle, croakers, moonfish, black mullet, blue runners, sheepshead, blackfin tuna, clams, clam juice and chowder, conches, shrimp, flounder, porgies, redfish, drums, red snapper, catfish, sea urchin, scallops, king mackerel, fish meal, bluefish, little tunny, sharks, and others.

U.S. companies can obtain a copy of the report entitled "Foodex '82 and Trade Mission (Japan, USA)" for $5 by requesting report number ITA-82-11-031 from NTIS.

Marketing Canned Fish in England

The United Kingdom imported over $170 million worth of canned fish in 1980. Except for herring and mackerel all major canned fish products must be imported to completely satisfy the domestic demand. The most significant import is canned salmon, amounting to over $100 million in 1980, or more than half of the total. One steadily growing import commodity is canned tuna. While tuna imports only totaled $23 million in 1980, they are rapidly becoming a major import commodity.

J.C.E.J. van der Eeden of Rotterdam, Holland, has prepared a 4-page report outlining the U.K. canned fish market. The report includes a product review of the six major canned fish products and advice on how to market these products in the United Kingdom. A copy of the report can be obtained by requesting the attachment to IFR-81/174, "The Market for

Canned Fish in the United Kingdom," from NMFS Statistics and Market News Offices, enclosing a self-addressed envelope with $0.37 postage.

Marine Birds, Mammals of the Puget Sound Region

Publication of **"Marine Birds and Mammals of Puget Sound,"** announced by the University of Washington Press, is the third in a series of books on that region's marine resources, physical properties, and uses. Supported by NOAA's Office of Marine Pollution Assessment, the Washington Sea Grant program, and the Environmental Protection Agency, the volume presents a fairly thorough, if sometimes personal, description of those marine species and their habitat needs by authors Tony Angell and Kenneth C. Balcomb III. Angell is an award winning artist and Balcomb is a marine biologist who has specialized in marine mammal studies.

The book begins with a brief review of the habitats of the Puget Sound estuary and the forces that impinge upon them (i.e., pollution, habitat losses/modification, and other human uses). The bulk of the book is given to the status, distribution, foods, and critical habitats of 14 marine mammals and 124 aquatic, shore, and predatory birds that frequent the Sound.

An appendix provides additional data for the listed species on their feeding strategies, nesting and breeding areas, feeding and resting areas, the impact of various human activities on them, and their occurrence, by month, in Puget Sound. Other appended data include the use by various species groups of different types of habitat, a regional map, and smaller maps keyed to marine bird areas, pinniped haulouts, cetacean sitings, eelgrass and kelp beds, and salt marshes. Brief life history notes are also given for the marine mammals. While the book is not a field guide, most species are well illustrated. Considerable use of personal anecdotes makes the book attractive to general readers, and those more technically inclined will find the data from a wide variety of often obscure sources—on species distribution, habitat, etc.—useful. Indexed, the 145-page 8½ × 11″ paperbound volume is available from the University of Washington Press, Seattle, WA 98105 for $14.50 plus $1.75 postage and handling.

Indian and Philippine Fishery Data Available

During India's 1981 Fiscal Year (IFY) (April 1981-March 1982), the value of Indian fishery exports increased by almost US$7 million to a record value of US$300 million. However, the quantity of Indian fishery exports decreased from 75,600 metric tons (t) in IFY 1980 to only 70,100 t in IFY 1981. Frozen shrimp accounted for 65 percent by quantity and 84 percent by value of India's total fishery exports. Over 75 percent of India's shrimp exports was shipped to the United States.

The U.S. Embassy in New Delhi has prepared an 11-page report describing recent developments in the country's fishing industry, Indian fishery exports, and its Five-Year Plan. Also included in the report is a list of marine equipment and seafood processing machinery for which U.S. manufacturers may have good sales prospects in India. U.S. companies can order this report for $5.00 by requesting report number ITA-82-10-021 from: NTIS, U.S. Department of Commerce, Springfield, VA 22161.

The Philippine fishing industry is an important sector of the national economy, accounting for about 4.2 percent of the country's Gross National Product (GNP) and supporting an estimated 5 million people. Philippine fishermen caught 1.8 million metric tons (t) in 1981, an increase of over 100,000 t, or about 10 percent over the 1980 catch. Philippine fishery exports, however, declined in 1981 to 65,700 t from 76,000 t in 1980.

The Philippine Government announced in February 1982 the formation of the Philippine Fishery Development Authority (FFDA) which will attempt to accelerate the development of the fishery industry in the Philippines and will consolidate several fishery-related agencies in the Philippine Government. The U.S. Embassy in Manila has prepared a 13-page report describing recent developments in the country's fishing industry and its fisheries development program. U.S. companies can order this report for $5.00 by requesting report number ITA-82-11-026 from the NTIS.

New Chilean Fishery Publications

Two publications have recently been released in Chile which may be of interest to U.S. researchers. The publications were sponsored by the state-owned development corporation, Corporacion de Fomento de la Produccion (CORFO). CORFO and the Instituto de Fomento Pesquero (IFOP) have released an English language version of its **Chilean Fisheries Resources Catalog.** It contains information and color photographs on 40 of the most important commercial species caught by Chilean fishermen. The catalog also includes notes on the laws and regulations affecting those species. Copies of the publication cost $20.00 plus mailing charges and can be ordered from the Instituto de Fomento Pesquero, Casilla 1287, Santiago, Chile.

CORFO has also sponsored research on mussel culture as a possible economic activity along Chile's lightly populated southern coast. CORFO awarded a contract to the Servicio de Cooperaction Tecnica (SERCOTEC) to study the Chilean mussel, *Mytilus chilensis*, which is larger than the mussel familiar to most U.S. and European consumers. A copy of the resulting three-volume report can be ordered for $102.57 plus tax by writing to the Corporacion de Fomento de la Produccion, Gerencia de Desarrollo, Casilla 3886, Santiago, Chile. (Source: IFR-81/178.)

Meetings, Conferences, and Early Fisheries Results

. . . . **An International Conference on Sail-Assisted Commercial Fishing Vessels** has been scheduled for 16-18 May 1983 in Tarpon Springs, Fla. Sponsors are the Florida Sea Grant College, University of South Florida College of Engineering, and the Virginia Sea Grant Program (VIMS), assisted by SAILA (Sail Assist International Liaison Associates) and SNAME Southeast (The Society of Naval Architects and Marine Engineers Southeast Section). Purpose of the conference is to explore current and projected uses of wind to help commercial fishing vessels minimize dependence on petroleum-based fuels. The tentative program will include sessions on modern commercial sailing fishing vessels, potential fisheries for sail-assisted vessels, retrofit of existing powered craft with sails, new hull designs, one- and two-man sail fishing vessels, economics, safety and stability, insurance, sail rigs and materials, and more. For more information contact John W. Shortall, III, NA, College of Engineering, University of South Florida, Tampa, FL 33620 . . . .

. . . . The Food and Agriculture Organization (FAO) of the United Nations is planning a two-part **World Conference on Fisheries Management and Development** for later this year and 1984. The FAO hopes that the conference will increase the understanding of changes in world fisheries resulting from the new legal regime of the oceans and draw attention to the changed prospects and new conditions for fisheries development and management. In the first phase of the conference, a series of technical consultations will be held to prepare papers for an extended November 1983 meeting of the FAO Committee on Fisheries (COFI) in Rome. The final World Conference, set for May 1984 in Rome, will consider policy implications of the issues discussed at the COFI technical meeting . . . .

. . . . **Pesca/Atlapa Expo '83, a conference and exhibition** devoted to equipment, products, services, and technology needed to meet the demands of the expanding fishing industries in Latin America has been scheduled for 22-24 March 1983 in Panama City, Panama. The exhibition is sponsored by the Panamanian National Association for the Fishing Industry in cooperation with the Panamanian Ministry of Commerce and Industry and the National Port Authority. For further information contact Henry C. Lepinske, Oakbrook Exposition Management, Ltd., 1000 Jorie Blvd., Oak Brook, IL 60521 . . . .

. . . . The Duke University Marine Laboratory and the Fundacao Universidade do Rio Grande are organizing the **International Symposium on Utilization of Coastal Ecosystems:** Planning, Pollution, and Productivity. It will be held in Rio Grande do Sul, Brazil, 22-27 November 1983. For further information, contact Secretary-General Labbish N. Chao, Local Committee, The International Symposium, University of Rio Grande, Caixa Postal 474, 96200 Rio Grande, RGS, Brazil . . . .

. . . . Alaska Fish and Game Department **biologists expect another unusually large statewide salmon harvest in 1983.** For 3 years the commercial catch has hovered near 110 million fish, though the 1982 harvest was expected to drop a bit to 95 million fish. Biologists anticipate a continuation of plentiful salmon harvests in most areas of the State, but fewer pink salmon returning to southeast Alaska in 1983. Fishing industry profits, down sharply in 1982 because of declines in salmon prices, could improve in 1983 if market demand for frozen and canned salmon rises, state officials predict . . . .

. . . . Texas fishery biologists, who have been **hoping for signs of a return of the tarpon** to that state's coastal waters for the past decade, report finding such evidence last year, with 11 immature tarpon being taken in Department of Parks and Wildlife nets in Texas bays. Sport fishermen also reported taking tarpon in Galveston Bay and Pass Cavallo. Four tarpon taken in a survey gill net near Corpus Christi late last year averaged 27 inches long and the largest weighed 9 pounds. The Texas coast once hosted many tarpon angling tournaments . . . .

. . . . Oregon's 1982 shrimp season **closed on 31 October with the lowest annual landings of shrimp in the past decade**. A little over 18 million pounds were landed during the season, including about 7 million pounds landed on the north coast, 4.5 million pounds on the central coast, and 6.5 million pounds on the south coast. It was a drop of 29 percent from 1981 landings of 25.6 million pounds. The ex-vessel price for the season ranged from $0.30 to $0.60/pound with most running $0.50-0.60/pound . . . .

. . . . Alaska's 1982 Bristol Bay **king crab season lasted just 26 days, the shortest** since the fishery's development in 1970, according to the Department of Fish and Game. The season was closed with only 2,400,000 pounds delivered when fishery observer data indicated that only 15 million females were carrying full egg clutches. It is estimated that 20-40 million egg-bearing females are needed to maintain the stock at good levels. The harvest was stopped to protect all mature male crabs potentially able to breed with the barren females. Scientists also anticipated that the 1983 harvest may remain at the same level as 1982 . . . .

Editorial Guidelines for *Marine Fisheries Review*

Marine Fisheries Review publishes review articles, original research reports, significant progress reports, technical notes, and news articles on fisheries science, engineering, and economics, commercial and recreational fisheries, marine mammal studies, aquaculture, and U.S. and foreign fisheries developments. Emphasis, however, is on in-depth review articles and practical or applied aspects of marine fisheries rather than pure research.

Preferred paper length ranges from 4 to 12 printed pages (about 10-40 manuscript pages), although shorter and longer papers are sometimes accepted. Papers are normally printed within 4-6 months of acceptance. Publication is hastened when manuscripts conform to the following recommended guidelines.

The Manuscript

Submission of a manuscript to *Marine Fisheries Review* implies that the manuscript is the author's own work, has not been submitted for publication elsewhere, and is ready for publication as submitted. Commerce Department personnel should submit papers under completed NOAA Form 25-700.

Manuscripts must be typed (double-spaced) on high-quality white bond paper and submitted with two duplicate (but not carbon) copies. The complete manuscript normally includes a title page, a short abstract (if needed), text, literature citations, tables, figure legends, footnotes, and the figures. The title page should carry the title and the name, department, institution or other affiliation, and complete address (plus current address if different) of the author(s). Manuscript pages should be numbered and have 1½-inch margins on all sides. Running heads are not used. An "Acknowledgment" section, if needed, may be placed at the end of the text. Use of appendices is discouraged.

Abstract and Headings

Keep titles, heading, subheadings, and the abstract short and clear. Abstracts should be short (one-half page or less) and double-spaced. Paper titles should be no longer than 60 characters; a four- to five-word (40 to 45 characters) title is ideal. Use heads sparingly, if at all. Heads should contain only 2-5 words; do not stack heads of different sizes.

Style

In style, *Marine Fisheries Review* follows the "U.S. Government Printing Office Style Manual." Fish names follow the American Fisheries Society's Special Publication No. 6, "A List of Common and Scientific Names of Fishes from the United States and Canada," third edition, 1970. The "Merriam-Webster Third New International Dictionary" is used as the authority for correct spelling and word division. Only journal titles and scientific names (genera and species) should be italicized (underscored). Dates should be written as 3 November 1976. In text, literature is cited as Lynn and Reid (1968) or as (Lynn and Reid, 1968). Common abbreviations and symbols such as mm, m, g, ml, mg, and °C (without periods) may be used with numerals. Measurements are preferred in metric units; other equivalent units (i.e., fathoms, °F) may also be listed in parentheses.

Tables and Footnotes

Tables and footnotes should be typed separately and double-spaced. Tables should be numbered and referenced in text. Table headings and format should be consistent; do not use vertical rules.

Literature Citations

Title the list of references "Literature Citations" and include only published works or those actually in press. Citations must contain the complete title of the work, inclusive pagination, full journal title, the year and month and volume and issue numbers of the publication. Unpublished reports or manuscripts and personal communications must be footnoted. Include the title, author, pagination of the manuscript or report, and the address where it is on file. For personal communications, list the name, affiliation, and address of the communicator.

Citations should be double-spaced and listed alphabetically by the senior author's surname and initials. Co-authors should be listed by initials and surname. Where two or more citations have the same author(s), list them chronologically; where both author and year match on two or more, use lowercase alphabet to distinguish them (1969a, 1969b, 1969c, etc.).

Authors must double-check all literature cited; they alone are responsible for its accuracy.

Figures

All figures should be clearly identified with the author's name and figure number, if used. Figure legends should be brief and a copy may be taped to the back of the figure. Figures may or may not be numbered. Do not write on the back of photographs. Photographs should be black and white, 8- × 10- inches, sharply focused glossies of strong contrast. Potential cover photos are welcome but their return cannot be guaranteed. Magnification listed for photomicrographs must match the figure submitted (a scale bar may be preferred).

Line art should be drawn with black India ink on white paper. Design, symbols, and lettering should be neat, legible, and simple. Avoid freehand lettering and heavy lettering and shading that could fill in when the figure is reduced. Consider column and page sizes when designing figures.

Finally

First-rate, professional papers are neat, accurate, and complete. Authors should proofread the manuscript for typographical errors and double-check its contents and appearance before submission. Mail the manuscript flat, first-class mail, to: Editor, *Marine Fisheries Review*, Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way N.E., BIN C15700, Seattle, WA 98115.

The senior author will receive 50 reprints (no cover) of his paper free of charge and 100 free copies are supplied to his organization. Cost estimates for additional reprints can be supplied upon request.

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